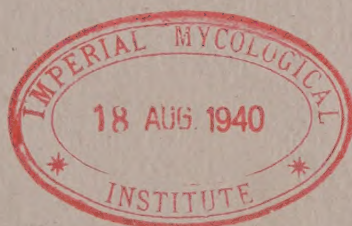


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JUNE, 1940.

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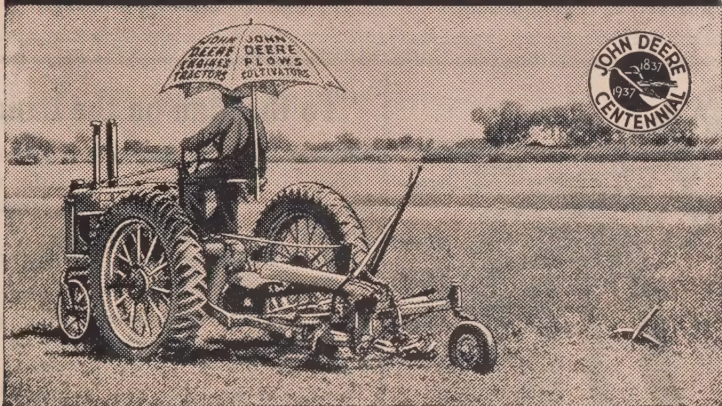
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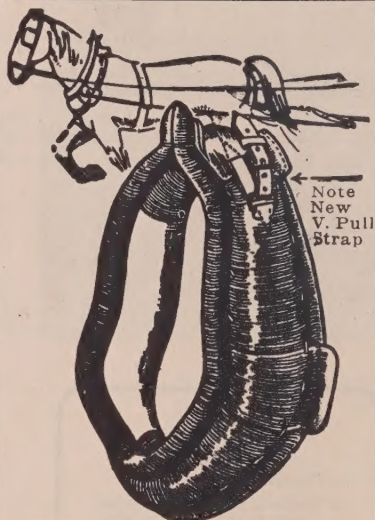
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JUNE, 1940

Linking Research with Extension*

It seems to be generally conceded that in spite of our existing organisations there remains a serious lag between the elucidation of a problem by research workers and its actual application by the farmer. Even so, I make no apology for choosing this as the subject of address at the first meeting of the Animal Health Club. I do so firstly, because it is a matter in which we are all vitally interested, and the closer liaison of those in research with those in education and extension is acknowledged to be one of the chief aims of the Club. My second reason is that I believe the subject is often the victim of a mere cursory glance, whereas it is worthy of more careful and detailed scrutiny by us all—research officers, educationalists and extension officers alike.

* Address by Dr. A. R. Callaghan to the first meeting of the Animal Health Club, Adelaide, on 10th May, 1940.

At the outset, everyone will undoubtedly admit that in agriculture and animal husbandry the results of scientific discovery are, for the most part, slow to find practical, and especially universal, application. The causes are partly inherent in the problem itself, and partly due to a lack of appreciation of its significance in our organisation. Inherently the trouble lies in the necessity for education and dissemination with respect to research results until they reach the multitude of farmers, who constitute separate, and to a large extent, distinct units of production. In industrial research the link between research and application is more direct, simply because factories are the units concerned with application; the employees, or actual producers in this case, having no executive power. I am not saying that industrially all scientific knowledge is utilised; far from it, but the inherent difficulties are less in the industrial sphere than they are in primary production. An extreme case is that of aeronautical research. Here the findings of the research officer are put into almost immediate use. In chemical research a formidable store of fundamental knowledge remains latent, or partially latent, largely because of the wide diversity of interests which chemical findings are likely to serve. When it comes to research into the problems of agriculture and animal husbandry, the more precise, clear cut findings are readily acceptable, mainly because such findings have direct and spectacular application. Grouped in this category are specific treatments, or correctives, for plant or animal diseases. Without the application of such treatments the enterprise concerned is liable to failure, whereas the application of the treatment is an assurance against failure. Necessity in this case links the research officer with the producer. It is a case of direct contact, a contact which enables the research officer to grasp the practical essentials of the problem and, in turn, give an essentially practical solution. In forestry a similar relationship exists between research and application. Unfortunately, in the general field of rural production improvement in methods and procedure cannot be so directly demonstrated, nor can the same direct contacts be so readily made. The farmer is ignorant of the scientific laws which are the research officer's stock-in-trade, just as the research officer is in turn frequently ignorant of the inexorable practical laws which are the farmer's stock-in-trade in his battle of wits with nature. Happily enough I believe that a genuine realisation of these differences is gradually helping the farmer to become more tolerant, and the research officer to be more helpful. The fact remains, however, that supervening between the research worker and the average farmer is the necessity for agricultural education, and the inherent difficulties that exist have prompted us to build an organisation which includes education and the extension of knowledge to those who are in a position to make direct use of it. Our organisation aims to supply the multitude of individual farmers concerned with all the most helpful information available.

The organisation which we have in Australia consists of the Council for Scientific and Industrial Research and the Waite Institute as the main centres

of research. In education we have the Faculties of Agriculture and the Agricultural Colleges. For extension the various Departments of Agriculture are almost wholly responsible. These Departments incidentally are responsible for the administration of acts directly relating to rural production. Some Departments of Agriculture and most Faculties of Agriculture contribute in some measure to fundamental research. The Agricultural Colleges carry out experimental work and incidental investigations, and make initial use of knowledge made available as a result of research effort. I am strongly of opinion that the Agricultural Colleges should be more fully utilised in this way. It should not be a case of the colleges asking or finding out for themselves what they will do now, but it should be a case of being asked to do something by way of co-operating and helping in the practical fulfilment of research.

Only university trained men are employed in research. It is considered—quite rightly—that only men of ability and well trained in science are fitted for such work. Frequently, and more often than not, such men have little real practical perspective as far as the vocation of farming and all it entails is concerned. When a university graduate enters the field of research, he becomes, again quite rightly, absorbed in the particular, and be it said, often restricted line of research. He becomes, of necessity, for the time being at least, a specialist absorbed in the solution of a special problem. Because of the scientific background which constantly engages his mind, scientific thought and scientific expression become easier, and in keeping with this growth he is able to undertake increasingly more complicated investigations. In the meantime the simpler underlying principles which activate his investigations and control his thoughts become so obvious to him that they join his subconscious mind. His powers of expression are limited to the scientific phraseology with which he works from day to day. Findings are recorded in technical language, which are essentially directed to his colleagues working in the same or similar fields. The information so provided is, I believe, for the most part available to university graduates by virtue of their training, but in some cases the data call for interpretation from one who has specialised in the particular field. I do not wish you to think for one moment that this should not be so. I am firmly convinced that the ideal research officer is one that follows his investigations with the true spirit of enquiry and is not easily distracted. His job essentially is to add to our fundamental knowledge. He should not be encumbered by the need for disseminating the results of his own researches. For this reason, I believe that the research officer is quite within his rights in communicating his findings in the most facile language known to him. Only when his work may have direct practical implications, and he alone holds the key to its dissemination, should it be inexcusable for him to do otherwise.

Having agreed that research workers have a right to express their findings in the terms and expressions best known to them, may I implore them to

choose the titles to such papers from the same technical vocabulary. Many bulletins and pamphlets of a highly technical nature issued by the C.S.I.R. carry very enticing practical titles. It is exasperating in the extreme for those of us who are engaged in education and extension to take up a bulletin on a subject that purports to deal with the very practical problem that is exercising our minds, only to discover that it is full of higher mathematics and Greek hieroglyphics. The facts that are contained in such bulletins are so completely camouflaged that their distribution to other than technical workers is an extravagance, but when they are sent out and publicised with the most intriguing titles which flatter their practical value, their widespread distribution is not only an extravagance, but a mistake.

Application of knowledge in the field, with its manifold practical implications, brings the research officer into contact with a realm entirely different from that under which he is constantly at work. Most research officers realise and admit their disabilities, and are prepared to acknowledge the work of extension officers to be as specialised as their own. A few, sublimely unconscious of their practical limitations, consider they can not only do both but that they can do them with equal effectiveness. This is more often a fallacy than not, and for that reason I believe the correct answer to be closer and more willing co-operation and especially a closer and more willing co-ordination of effort. If we all realised that the extension officer is a specialist in his job just as much as we are in ours, I feel sure that a lot of uncalled for distinctions between the different branches of our profession would disappear.

Recently I advocated the appointment of liaison officers to the main branches of the C.S.I.R. Such officers might well be part and parcel of the C.S.I.R. working in close association with the research workers and making sure that all educational bodies and extension services are supplied with clear and lucid interpretations of the research findings. I am sure that if the C.S.I.R. would make a definite point of disseminating their findings in a readily available form to officers engaged in the application of new knowledge and in the education of those who will ultimately be responsible for carrying it to the farmer, it would gain prestige and enhance its usefulness beyond recognition.

The appointment of a publicity officer in no way fills the requirements. The C.S.I.R. should not need publicity and propaganda, and I fail to see that any one publicity officer can possibly provide the education and extension officers of our profession with the information they require and which they are entitled to receive.

At the outset I referred to the inherent difficulties that made difficult the proper dissemination of knowledge to the farmer, and that there was a lack of appreciation of the significance of these difficulties in our organisation. But there is one very deep-rooted trouble which I think must be corrected by some long-term planning, coupled with a genuine realisation that such is desirable.

The present trouble is that our organisation is top-heavy. We have prosecuted research with vigour and intensity and we all agree that such efforts should go on. In the meantime, however, the problem of making use of that knowledge must be more realistically tackled. The more new knowledge made, the greater becomes the problem. In other words, the faster the research worker turns out new knowledge the more extensive becomes the job of teaching. Unfortunately, the research atmosphere has been all pervading, it has stolen the limelight, and has dominated our agricultural organisation to the comparative neglect of the extension services. In education, for instance, we have witnessed an inordinate greed on the part of universities for competent research workers. I admit that undoubtedly the education of young men entering the profession should be carried out in an atmosphere of enquiry, but I do not admit that ability in research should be the *sine qua non* for appointment to teaching posts at our universities. The scientific research officer may not be, and in many cases is not, temperamentally suited to instructional work. To such a man, instruction of students becomes an irksome, uninspiring duty that takes him away for hours at a time from the more absorbing problem awaiting his attention in the laboratory. There would be some justification for this if our object was solely to train research men. Isn't there a subtle difference, however, between education in the general sense and education in the specialised sense? Shouldn't the distinction lie between undergraduate training and post-graduate training? There seems to be confusion in the minds of those responsible for the education of university men between what, in my opinion, should be regarded essentially as post-graduate work, and what should be essentially undergraduate. I once wrote, with good pressure on the pen, that "University students—never to be taken too seriously, it is admitted—should not feel the urge to hold meetings of protest against the uninspiring tedious machinations of dictated instruction; they have a claim and just right to look for more eloquent treatment of the subjects they study". Unfortunately they fall victims as undergraduates to highly trained graduate minds which insist on a highly specialised knowledge in their particular subject even though there are half a dozen or more such subjects receiving the same advanced treatment. Students so trained are brought up with research as their slogan and they find it exceptionally hard to orientate the multitude of elaborate scientific facts into practical perspective. They are, in fact, better equipped for laboratory work than for field work. This is quite all right if the be-all and end-all of research was research, but it is not. The end point of research is surely the universal application of its findings. Who then is to see that the end point is reached?

A number of university graduates find their way into education services while a few enter the advisory services, but I cannot help believing that unless they have either had practical experience on the land beforehand, or have had the benefit of three years' training at an agricultural college, their training

has been along the wrong lines. If, by chance, they have natural gifts for the work they undertake, then their innate ability will rescue them. University graduates have been absorbed by the research services where the demand has been strong and the initial salaries offered attractive. For the most part therefore, the responsibility for training extension officers has been vested in the agricultural colleges. The agricultural colleges in the meantime have been treated like Cinderella in the fairy story. The more dignified sisters have had all the good things that go to make them attractive, they have been lauded and praised and public opinion has been trained to look upon them with awe inspiring wonder and confidence. Cinderella, on the other hand, has had to be content to bask in their reflected glory. In other words, public opinion has been trained to think in terms of research and has not hesitated to provide funds for its prosecution. On the other hand, the educational and extension services have had to be content with less. That they should have made sacrifices for research effort is obvious, but unfortunately our policy has become top-heavy and unbalanced. The tendency has been for the services to remain static in spite of the dynamic progress of research.

Education represents the link between research and extension. Consequently one of the most important functions of education in primary production is to train extension workers. While ever we go on giving highly technical training to our university men and while ever they continue to be recruited for research, the gulf separating the extension officer and the research worker will become increasingly great. There must be a keener realisation of the need for the proper training of those entering the extension services. The present university courses in themselves cannot do this adequately, chiefly because they have developed their training into purely technical channels, but I believe that the most capable young men taking their diplomas in agriculture from the agricultural colleges should be encouraged, and, if need be, assisted to finish their training at the universities. Such men make the best extension workers under our present system, and I am happy to say that recently the South Australian Government has seen fit to recognise this and to offer cadetships to the value of £100 per annum to the most capable of the diploma graduates from Roseworthy to enable them to go on to the university. These men are to be trained for employment in the extension and education services of the State.

At present agricultural college appointments call essentially for practical men, because funds are limited and teaching is only a portion of the duties. They must be capable of supervising that branch of work on the farm which concerns them, as well as be capable of giving adequate practical instruction to students in that subject. In addition, they are expected to carry out experimental and investigational work of utilitarian significance. In the meantime, they have to equip themselves and keep themselves as up-to-date as possible in their particular subject. That subject is not a specialised one. For instance, an instructor in sheep husbandry is concerned not only with

nutritional problems but with problems of disease, disorders, breeds, markets, management and general husbandry. Surely the training of such officers should be as sound and as intense as that of the research officers.

All the agricultural colleges of Australia are forced to carry out their important duties understaffed and certainly lacking a fully trained technical staff. They are doing magnificent work with the funds at their disposal, and under the existing relationships between the units of our agricultural organisation, but what a difference more balanced attention and more financial aid would make. If the C.S.I.R., for instance, recognised the colleges as the real link between their findings and the extension officer, it would not hesitate to appoint liaison officers to co-operate with the other services and make the efforts of research workers readily available. I believe that such an arrangement would afford a refreshing example of the much talked of co-ordination. It would go a long way towards the direct and early solution of the difficulties. Indirectly it would focus public opinion on the very important part education must play in the ultimate fulfilment of research plans in agriculture and animal husbandry.

British Agriculture Revisited*

By

S. M. WADHAM, M.A., Dip.Agr.,

Professor of Agriculture, The University, Melbourne, Vic.

A year's study leave gave the opportunity of looking at the agricultural systems of the Old Country and making certain observations. The kindness of directors of British agricultural research centres and other organisations connected with agriculture, made it possible to discuss conclusions in a very frank manner. I am most grateful to all these gentlemen for their assistance in these discussions. I accept full responsibility for the views here stated, but naturally I would not have put them forward had they been out of line with current trend of informed opinion. The word "informed" requires some emphasis, because the general body of public opinion in the country seems to me to be relatively disinterested in the matter, and, when interested, largely misled.

External Changes in Thirteen Years.

The countryside as a whole seemed much the same as in 1926, when I first left England for Australia. In some ways things were tidier; there were fewer horrible hoardings disfiguring the main roads; in general the new houses

* Address to Victorian Branch of the Institute on 28th February, 1940.

which were in evidence in every town and village were neat and not unpleasing in their architecture ; however, the countryside of most districts was less pleasing than formerly. Hedges were more straggly, and, on the poorer soils, stretches of what had been pasture land were becoming derelict through recolonisation by bushes and scrub. Rabbits were generally abundant and most people who know Australia agreed that the rabbit pest is at the present time worse in England than in our better rainfall districts.

Tractors were far more evident than formerly ; a natural response to the need for getting more done in a man's working day. The general standard of cultivation seemed to have declined somewhat, although it is still high, particularly high in such localities as the Fens. On the heavier soils where cultivation costs are high and crops fail in wet seasons unless there is an efficient drainage system, fairly large tracts of land have gone out of cultivation. Such areas have either tumbled down to pasture or scrub.

There were quite a number of innovations. A certain number of settlements of small holdings have appeared in various places. Poultry were more obvious because large numbers are now kept on the grass paddocks in arable rotations. Here and there a " Hosier " dairy unit might be seen standing like a child's toy train in the middle of the nursery floor, the improved appearance of the surrounding paddocks usually witnessing the benefit of the system to all who care to see. Rather more orchards—in the newer ones the trees grown close together in rows on dwarf stocks, while the older plantations of the cottage gardens were often as unkempt as of old. The latter are the curse of the fruit industry ; they produce large crops in favourable seasons and depress the general price accordingly ; in bad years they are neglected and serve as distributing centres for various pests and diseases.

The one outstanding feature was the high general level of quality in the livestock as judged by external observation. This is the pride of British agriculture and has become a tradition which no farmer is prepared to relinquish. It is based on two ideas. First, that stock are essential for the maintenance of soil fertility and, secondly, the genuine desire to turn out stock in first class condition for the market, coupled with definite pride in the possession of good-looking animals. These features are traditional, but require much further investigation on economic lines. On all sides the cry is raised that livestock do not pay. Cattle are sometimes only kept for the reason that they produce farmyard manure ; fat lambs are said to be unremunerative unless they fetch 35/- to 45/- or more, according to the season of production. Expensive though they may be, the stock look well to one who has become used to the effect of droughts, and to the maintenance of animals at all seasons on grass alone or with the very minimum of purchased foodstuffs.

Another change one noticed was the great development of road haulage for farm produce. Regulations governing the use of this transport seemed to

be as strict as in Victoria, but the whole system is much more convenient in its direct farm-to-market service and the costs are very definitely lower than road-and-rail. The road surfaces have been brought to a high level of perfection, but they are still too narrow, and little has been done in the way of cutting out awkward bottlenecks in the small towns. By-passes occur in some places, but they are regrettably few. Even the best roads are, of course, poor affairs when compared with Reichsautobahnen of Germany, which, however, seem to have gone to the other extreme—over-elaboration.

Although it would be ridiculous to describe the agriculture of a country with an average yield of 33 bushels of wheat and 6·5 tons of potatoes to the acre as decadent, yet the changes produced by the past fourteen years in the general condition of British agriculture have been retrogressive. The reasons for them are not difficult to discern.

The Controlling Factors.

(a) *Capital.* A dominant factor in the situation is the decline in the amount of capital available for both long and short term farm enterprises. This must be linked with the fall in agricultural prices and the uncertainty of profits. For British agriculture, the depression began in 1920–21 when the index number of agricultural prices fell from 313 to 176 and at the same time costs remained high. The subsequent depression of 1929–35, in the course of which the general agricultural price index fell to 100 (June, 1933), was of course even more severe. In it many farmers were ruined, and practically all suffered great losses of available capital; landlords were forced to cut rents wholesale, confidence in the industry was lost and has not yet been restored. The result is that not only do many farmers find it somewhat difficult to raise the necessary cash for current operations, but neither farmers nor landlords are prepared to spend sums on permanent improvements.

The lack of drainage now particularly evident on the heavier clay lands is a case in point. These areas were originally tile-drained about 1850–1870 and now much of the equipment requires either complete overhaul or replacement. The land can be bought for about £5 to £8 per acre, and apparently no one has sufficient confidence to spend the £10 to £20 per acre without which it is virtually impossible to farm it intensively. It is here that the country might improve its yield of cereals without diminishing seriously the acreage devoted to other useful purposes. A comprehensive plan for subsidised drainage schemes would have been most advantageous in recent years, but politically it seems to have been unacceptable—presumably because government could not face the criticism which might have suggested they were doing something which benefited the private property owner. It seems a pity that the opportunity of thus employing in the creation of a national asset some of the tragic surplus of labour which existed for several years was allowed

to slip by. The dole, devastating in its moral and physical effects, had the merit of being politically impeccable.

(b) *Wages.* The second major factor is the stabilisation in the wages of rural workers. Among the thoughtful farmers, few regret this movement which has taken place since 1919. They realise that the maintenance of efficient labour on the farms, which is still difficult, would have been quite impossible without the regulation of wages and hours of work. In general the attitude taken by the District Wages Boards seems to be that payments must be sufficiently high to provide a reasonable standard of living.

Higher wages seem to be directly responsible for the straggly hedges and the failure to maintain things in as trim a state as in earlier years. Indirectly they are probably largely responsible for the increase in rabbits, which were once constantly shot and poached "for the pot"; but nowadays their control needs more organised effort and expenditure, although their eradication is virtually impossible in a country with the amount of cover characteristic of most districts.

The logical consequences of higher wages on a somewhat rigid agricultural system which is not over-capitalised can be either the drastic pruning of all processes requiring labour, and/or the modification of the system itself so as to require less labour per unit of production or, finally, in the extreme case, the abandonment of the system in favour of one which will use the land in a different way and will find a satisfactory economic balance. The simplest method of doing this is to reduce cropping in favour of grazing, but without some cropping the pastures on some of the soil types deteriorate rapidly.

On all sides there are wails about the drift of population to the urban areas, but this is the logical effect of the wage raising process in an industry which was certainly not over-capitalised and was once lavish in its use of manpower. Nowadays when 40/- to 45/- per week is an average wage, farmers cannot afford to have spare men about the place doing odd jobs for a large part of their time—as they used to be able to afford in days when wages were 14/- a week plus a cottage.

(c) *Relative Rigidity of the Systems of Cropping.* The basic idea lying behind the cropping systems is that the fertility of the soil will only be maintained if rotations are adopted and, further, that these rotations should enable a large number of animals to be kept. The vegetable or animal wastes go back to the land and thus prevent deterioration in soil texture. Large quantities of cattle cake and other concentrated foods are used. It is noteworthy that the chances of a gradual development of deficiencies in minor elements are largely ruled out under such a scheme. The type of rotation followed varies with the district but the Norfolk system used on medium to light loams in the eastern counties may be taken as a central type. It comprises August-harvested wheat followed by a root crop planted in the following spring. The roots are either lifted and clamped and fed to cattle in yards or

stalls during the winter, or fed to folded sheep. The following crop is "spring corn" (oats or barley), under which a short term "seeds" mixture e.g. rye grass and red clover, is established. After the cereal is cut the seeds make progress and are ready for a crop of hay in the following spring. The summer usually gives some grazing on the "grass", or there may be an aftermath cut prior to the autumnal application of a heavy dressing of farmyard manure, followed by the preparation of the land for sowing wheat in October or November. Under this system the land is kept free from weeds by inter-cultivation carried out on the root crop, soil fertility is conserved, and the production of the farm comprises numerous marketable items (wheat, fat steers, sheep, barley or oats); thus the risk of a fall in the price of one commodity is spread.

Roots are the costly crop because of the large amount of labour involved in singling and hand hoeing and in carting to the yards. Moreover the roots bring but little cash return except in those districts where potatoes can be grown effectively. An efficient mechanisation of inter- and intra-cultivation for these new crops would have been of major importance. The second most expensive operation is that of handling the farmyard manure in the yards and distributing it on the land. The only way of avoiding this item of cost seems to be to feed the stock on the paddocks themselves, which is by no means easy under the prevailing weather conditions of the winter. On the other crops, costs of production could be cut by the adoption of greater mechanisation, provided the fields could be adjusted in size and shape so as to permit of the employment of large scale machinery. But both the machinery and the reorganisation require capital, and this is frequently lacking.

These are the lines on which the old rotations could have been kept going, but in the main they have not been followed—partly because the farmers are innately conservative, partly because they often lack capital, and partly because they have hoped that something would turn up to tip the economic scale in their favour or that the Government would do something to rescue them from their plight.

Government Action in Agriculture.

One of the first steps was the stimulation of the sugar beet industry, under which numerous factories were erected and farmers received as much as 47/- per ton of beet in the early years. This helped with the root crop but until the practice of feeding the tops became general it failed to hold the same number of livestock. The sugar beet crop has its disabilities, it requires much potash, its particular species of eelworm is spreading and, on a wider view, it has caused social complications in the sugar areas of the West Indies which are bound to prove expensive. Financially it has helped certain sections of the home-farming community, but one may doubt whether the development was justified.

The decline in arable acreage and in the price of wheat stimulated the Government to start the Wheat Subsidy Scheme which fixed the home price at 45/- per quarter for a maximum quantity of the grain. As this price was certainly sufficient to cover costs on all but the heavy land, it acted as a palliative. Under it the area of wheat rose from 1.1 to 1.8 million acres between 1931 and 1938. However, as the acreage under oats and barley fell from 2.7 to 2.2 millions the guarantee did not achieve much in keeping land under cultivation. In 1938-39 a per-acre subsidy was offered to farmers to encourage them to plough up grassland, and after the outbreak of war compulsory powers were taken in this respect.

Stimulated by this guarantee some intrepid enthusiasts went so far as to equip their farms for cereal growing on the mechanised plan: growing two crops of wheat in three years. This involved considerable alteration in the size of fields and also the installation of driers to reduce the water content of the grain—a process which is necessary in a climate where moist conditions often prevail at harvest. This procedure, which certainly faced the problem in a sound manner in the economic sense, is of course regarded as extremely heterodox; it cuts across all the accepted lines of thought on soil fertility. One may be certain that soil texture difficulties would arise if it were adopted on clays or heavier loams. On lighter soils, however, it may prove partially successful unless the incidence of foot-rots, of which there are many types in the country, becomes too high. On all types of soil it may, in the long run, be expected to lead cumulatively to deficiency effects. Several of the “authorities” are cautious in their criticism; one of them pointed out to me that the old maxim “nothing pays better than muck” was coined before the correct use of artificials was worked out. All agreed that there is an urgent need for a close re-examination of the factors covering plant nutrition on each soil type. It was abundantly clear that the wheat enthusiasts were very much in a minority, and farming opinion generally was all against them.

Under Major Elliott various marketing boards were set up with the idea of avoiding inefficiencies in the marketing systems of various commodities. Some have been successful, while the fate of others hangs in the balance. The dairy industry was drifting into a semi-chaotic state prior to 1933, when it came under the Marketing Act. It is now operated under a system of regional pools. The prospect of greater stability in milk price has attracted more farmers to dairying, and the Board has had to face the marketing of an increased total milk production during its operation. It has managed to raise the average price to producers by about a penny per gallon—it stood at 12.92d. for 1937-38, but this has done little more than pay for the increased cost of feeding stuffs.

The dairy farmers have two grievances. The first is that the Board fixes minimum regional *retail* prices which are too high and thus prevent a larger consumption of liquid milk. The second is that the imports of manufactured dairy products at low prices, particularly from New Zealand and Australia

make the value of milk used for butter and other manufactures in Britain unduly low, and thus depress the average for the whole. The answer to the second complaint is easy ; it lies in the fact that if the retail prices of these products rose considerably the consumption would fall correspondingly. Cheese is not an essential item of diet, and the British working classes are quite ready to transfer their attention from butter to margarine. At times they have done so in the past, and they will do it again if circumstances force them. The answer to the first point requires more knowledge than I possess. Superficially, however, the distribution of milk in England seems worthy of criticism. In London there are several very large organisations which have secured virtual control and whose methods and speed of delivery would amuse a Melbourne milkman. Part of the trouble is doubtless due to the high level of service which the housewife has been brought up to expect. From the national standpoint, and also from that of the farmer, the present state of affairs is most unfortunate. As Sir Arthur Salter pointed out in an address last year, it may be that costs of retail distribution under the present scheme fully justify the prices which are charged, but this is not necessarily the end of the story. Probably the correct policy should be to scrap the present scheme of distribution and devise one which is more efficient. In any case, raising the retail price of whole-milk will not help the farmer—it will merely decrease consumption and throw a greater proportion of the product on the unprofitable manufacturing market. The net result is that the dairy farmer's only way to meet the rising costs of what he buys is to devise methods of reducing costs of operation.

Reduction of costs in dairying can certainly be achieved in some districts, but as a result of increased production, and there seem to be some grounds for supposing that the Government is not particularly anxious to increase the output of dairy products. The ways in which dairy costs could be lowered are, first and foremost, by a more liberal application of manures to pasture land. In some districts the results would be nearly as sensational as those which have followed on the practice of topdressing with "super." in southern Australia. But there are many farms on which pasture management already reaches a high standard. English pastures are far more complex in composition and structure than most of those to which we are accustomed, and the solution of their problems is by no means straightforward. The wider application of the work of Aberystwyth would certainly help.

On many areas the adoption of the Hosier system of outdoor dairying would certainly lower costs in a remarkable way. This system involves the use of a milking machine and bails arranged in small sheds on wheels which are moved on to a fresh piece of ground each day. The plant moves across the pastures and in this way the droppings are kept on the land, so that there is no expensive handling of muck and no general "drift" of fertility towards the homestead paddocks. The cows are given extensive supplementary feeding at milking time, and thus the losses of minerals in the milk are partly or wholly made good.

The system met with a good deal of ridicule at first, but it seems to be making steady headway. How far yields of milk are reduced by the extra exposure which the animals suffer during cold winters one cannot decide, nor is the range of soil types on which it can be successfully applied immediately discernible. It may be that in colder climates the loss in productivity due to the more rigorous conditions of the open fields would more than offset the loss due to increased infections among closely housed stock; but today the number of advocates of the system is increasing, and when the older generation of cowmen has passed away it will spread still faster. I believe the main obstacle lies in the conservatism of the operators.

The general quality of dairy stock is high, but disease problems are still very acute. The number of tuberculin-tested herds has increased somewhat, but contagious abortion and mammitis are probably far more prevalent than is admitted. One large producer told me he refused to consider the question of a pure bred herd because he had seen so many men lose large capital sums and the fruit of years of careful work through outbreaks of these two diseases. In his opinion a working farmer who started a pedigree herd before these two scourges had been overcome was putting the cart before the horse.

Another criticism which came from an authority interested in the economics of production was to the effect that many dairy farmers spend far too much on concentrated foodstuffs in maintaining the production of some of their cows at a level which is uneconomic. It is clear that this point requires much investigation in all dairying countries. The shape of the "lactation curve", its response to nutritional conditions, and its inheritance, are matters which require very serious attention in Australia as well as in Britain.

The potato crop has come under a marketing board and has also had the benefit of a prohibition of imports except in the case of "earlies". The country is now self-supporting in "main crop" varieties. A stabilising effect on the price could only be achieved by rationing the acreage under production, and limiting the percentage marketed in years of heavy crop. Neither of these necessary regulations is popular.

The pig industry has been the subject of much discussion. The system of selling either by contracts with the bacon factories or on the open market has led to comparisons unfavourable to the contract method. It is widely rumoured that there are far too many small and inefficient curing establishments. It is certain that there is a good deal of inefficient feeding of pigs.

On the poultry side there was definite progress. There has been a considerable expansion of poultry keeping in the last two decades. The battery system had some successes and then ran into great difficulties owing to disease. A system with much to commend it is that under which small coops, each of about 25 birds, are moved across the field in lines, each coop comprising a run with nesting boxes attached. One farmer on light land over limestone said that while fattening cattle had kept him poor for years, his poultry were giving good

results. The effect on soil fertility is said to be at least as good as dressing with yard manure. One asked why this method was not used more generally to replace the expensive cattle industry. One authority suggested that England already supplied the bulk of her fresh egg requirements, and it was probably in the interests of the national economy to be able to accept supplies of poultry produce from countries which were purchasers of manufactured products and which could not export grain. The further inquiry as to why young chickens were not sold in quantity at cheap rates as in continental countries where poultry keeping is well organised, evoked the response that the British housewife was a bad cook, and would not take the trouble which poultry requires.

The Agricultural Extension System and Agricultural Reform.

The extension system is organised by areas, and it is generally admitted that although in some districts it works excellently and is well able to put modern methods before practical farmers, yet it can scarcely be regarded as up-to-date in regions where officers who are not well equipped with the modern scientific viewpoint are in charge. Unfortunately the selection of these county organisers is not in the hands of a central organisation, and it is reasonable to assume that the local bodies will not always be in a position to assess the kind of technical training and knowledge which is most desirable in a man with the task of modernising agriculture. There is also some danger of a gap in the training of men for these posts. The university courses are naturally biased on the theoretical side, and those given at some of the agricultural colleges scarcely have a sufficiently scientific basis to enable their students to appreciate to the full the nature of modern technical progress. There is a considerable risk that the products of both organisations will continue to specialise in their own particular directions after their period of training is over. This means that unless special steps are taken to ensure a supply of men with properly balanced training, specially designed for extension work, there may be a lack of men with broad enough education and long enough practical experience to manage the system effectively. To the casual observer there seems to be a *prima facie* case for centralisation of the system, but no one is likely to adopt it. To the government it would mean additional expense and responsibility, to the local authorities it would mean loss of prestige, while the district conservatism of the farmer—who often assumes that his particular conditions are beyond the comprehension of a newcomer—would certainly resent any such scheme. A strong central Ministry of Agriculture could face the task, but the English Department has no reputation for strength. Meantime, although a fair number of farmers are doing well as a result of adopting more modern methods, the great majority are either too obstinate to learn or unable for other reasons to leave the older systems which keep them working for a small return.

The general effect of government policy has been to keep farming alive in an emaciated condition. The methods adopted have been palliative, rather than curative. Until the fundamental facts are faced and the remedy sought along the lines of increasing efficiency and lowering costs, no permanent progress will be made. Higher prices mean reduced consumption in most agricultural commodities unless the rise is accompanied by higher purchasing power, and this latter inevitably means higher costs of labour and other items which the farmer buys.

As matters stand at the moment, the tendency is to look to the government for financial assistance as each branch of the industry comes into difficulties. As a general result, initiative is cramped and the tendency is to go on patching the same basic methods, which were sound enough in days before the economic emancipation of labour and the advent of this age of scientific and mechanical invention. Consequently progress is necessarily slow, or even negligible.

A constructive policy of affording credit for specific purposes, in the direction of altering farms so as to reduce costs, or for purchasing equipment, coupled with a more progressive extension system, would have given farming more self respect and would have done more to overcome the conservative tendencies which are prevalent. What has been done is progressive, but it fails to reach the roots of the real problem.

One can well appreciate that there may be some foundation for the suggestion that the British Government did not particularly wish to see home production considerably increased during the period of acute world depression in agriculture. If this be the case, the method of maintaining the farming industries by direct subsidy and regulated prices was singularly unfortunate as a preparation for the present war. Possibly it was a still worse preparation for the reconstruction which must inevitably take place in the British economy when the war is over, and the loss of foreign assets makes it still more difficult to balance the national income account.

This survey would be incomplete without some reference to the labour problem and the attitude of mind of the farm workers.

The Labour Problem.

It has already been stated that the conditions of agricultural labour in England have been greatly improved. The system of wages boards has built up scales of payment which mean that the farm worker is today better off than the unskilled labourer in the city, if his allowances are taken into account and if he troubles to raise his own vegetables, poultry, etc. Yet there is a steady drift of men from the land to the cities and towns; in part this is general and must be taken as the inevitable result of mechanisation on some farms and the abandonment of others. Recently the drift has been aggravated by the large amount of contract work in rural areas due to the construction of aerodromes

and other works. In some districts, chiefly those adjacent to industrial towns, labour of an efficient character was really difficult to secure even before the war, whilst for casual work such as potato and beet lifting, the situation was only maintained by bands of Irishmen who come over for the season from the Free State—to the annoyance of enthusiastic students of economics in Dublin, be it remarked!

The causes of this failure of the better wage to hold the supply of labour are various. In the first place, the housing conditions are admittedly bad in many areas. Picturesque though some of the cottages may be, their comforts are often few and their conveniences negligible. On the other hand, the garish attractions of the towns are still magnetic, although rural transport disabilities have almost disappeared, thanks to bus services and the number of cars available. Meanwhile the life of the village as a community has in many cases suffered, partly through the counter attractions of the town, partly owing to the decay of the squirearchy, and possibly partly owing to the decline of the authority of both church and chapel. There is possibly some sense of inferiority about country labour, due to the immense, albeit unconscious, propaganda of the town. Half a century ago there was an intense pride in country life, a feeling of superiority in the mind of the country man; today this has gone. However, rural education is on the upgrade, and the establishment of agricultural high schools in some counties will do something to stop the decline of rural crafts. This may in turn stem the urban drift, but it will not be wholly successful in doing so unless housing facilities are improved. Boys and girls trained in well-equipped institutions will not be content to live in houses which are badly lighted and ventilated, which cannot be readily kept clean, and which have neither adequate water supplies nor sewerage systems.

The lack of an effective social ladder up which the labourer can mount to management of a farm and relative independence is a definite difficulty which prevents the more enterprising of the younger men from remaining on the land. The large amount of capital required to take over a leasehold is one of the main obstacles. (It must here be explained that there is little or no desire on the part of most working farmers in most districts to *own* land, and the capital investment required to take over the plant, stock and tenant right in a rented farm in the eastern counties is, on the average, £11 per acre.) The lack of short term credit and the general knowledge that the return is usually less per acre on small farms than on large, make small holdings less attractive. The energetic young man who could get the wage of a skilled farm worker sees no prospect of ever receiving more, and he therefore tries his luck in the town. He knows that most farmers themselves are not doing well financially.

An adjustment of housing and social conditions alone would not counteract this tendency. A revaluation of the relative importance of the various activities and satisfactions which go to make up the life of the individual might bring

about a change, but the driving force for such a tendency is scarcely in sight. A further prolonged period of urban depression might well start a series of changes in the general social outlook of the nation which could inaugurate a vast reorganisation of its rural life on a small-holding basis; but such a cataclysm is totally foreign to the British temperament, and it seems unlikely that it will take place. The present policy of patching the somewhat out-of-date structure is more likely to continue, except insofar as the farmers themselves achieve greater efficiency through improved methods. Whatever the future, the present agricultural labour position is definitely difficult and may be expected to become urgent if the war lasts for any long period.

America's New Deal in Agriculture

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In 1929, things began definitely to go amiss with the American farmer. Since the World War, 1914-18, agriculture had been existing in a state of fluctuating prosperity, trying to keep pace with the crazy finance of the industrial world in America. The policy of high tariffs, high prices, and heavy over-production, combined with a shrinking overseas market, brought the economic depression in its train, and the first man to feel the effects was the farmer. The first reaction was to put into practice the idea that the way to pay bills was to produce more—producing more meant flogging the land or using more machinery for large scale cheaper production. To pay for machinery, constant cropping was necessary, and that meant more goods to sell on an overfull market at low prices. When prices are low the grow more-sell more principle merely puts the farmer more hopelessly into debt. In addition the fertility of the soil decreased and erosion played havoc with the land. It was brought out in 1932 that a farmer's income was only half that of 1914. This was due to the fact that while the farmer paid 9 per cent. more for the same goods, he sold his own produce for 43 per cent. less than in 1914. Continuance of this state was impossible, and before remedial measures were instituted there had been a serious decline in the prosperity of the farmer, often to subsistence levels, accompanied by a no less serious degeneration of the soil.

A great deal has been said about the New Deal of President Roosevelt, often loosely and without a clear understanding of the idea behind it. Americans

themselves are highly critical of it, but as far as could be gathered last year, they have small idea of what to put in its place. At any rate in these days, they, and we also, cannot afford to be negative. What is this New Deal in agriculture? It may be summed up very briefly—stability and security: a policy of save the farmer and save the soil. The American farmers are a most independent and individualistic people; it is part of their creed to stand by the idea of a God-given right to plough their own furrow. They have clung to their right of possession of their land up to the stage of dispossession and then moved to new fields exactly as the "Okies" migrated westward to California and the Dakotans into Oregon and Washington in the last five years. But the New Deal has given a plan to keep farmers from moving; and even if it guarantees only a subsistence level of life, it has the merit of security. There has grown a spirit of co-operation, of community endeavour, which overrides independence and makes the group plan and helps its individual members. President Roosevelt has been interested, personally, in farming all his life and understands the farmers' position. No other leader seems to have grasped the problem so well or tried to do so much. What failure there is is not due to the *spirit* of the New Deal, whatever the criticism of its action.

The history of American farming in the past ten years has been disastrous, but the decline from as far back as 1920 has been severe. There are 6½ million farm families in the U.S.A., forming 22 per cent. of the population. In 1920 they received 15 per cent. of the total national income—in 1925, 11 per cent.—in 1928, 9 per cent., and in 1932, 7 per cent.; since 1932 most of the mass migrations have occurred which forced the nation to take an active part in stabilising the agricultural industry. There was pressure on land in some places when the closing factory doors sent jobless sons to their father's farm and in other places the land was abandoned. Last year the Texas and, Oklahoma panhandles, and the adjoining parts of Kansas and Colorado which form the very heart of the famous "Dustbowl" presented a very un-spring-like picture in April. In driving 50 miles through the Oklahoma panhandle into Kansas and into south-western Colorado, there was not one mile of green to be seen. Odd patches of sprouting wheat and some of the ubiquitous roly poly did not relieve the grey and brown landscape of windblown soils and dead grass. Drifting soil had shaved off the grass and young wheat plants and piled itself in hummocks and along fence rows. The resident owners had walked off, absentee landlords had given up the task and the mortgagees from New York to San Francisco were waiting for the promise of a good year or high prices to return. At this time 300,000 migrants from degenerated lands west of the Mississippi were moving with the tide of employment, hopelessly up and down California, while Oregon and Washington tried to absorb the human stream from Montana, the Dakotas and Nebraska. Through Tennessee and the southern States there was poor living for the farmers and an increase in tenancy and share cropping. The average farm income in Alabama in 1938 was about

500 dollars, as compared with 2,500 dollars in Iowa as the most prosperous State in the Union.

The story of land misuse and erosion painted so vividly by the publicity men in the Department of Agriculture of the southern part of the country did not need exaggeration. Travelling in 1939 through these south-eastern States gave the impression that commonly the farmers were far from secure. At the last census in 1930, 42 per cent. of all the farmers in the U.S. were tenants who farmed 43 per cent. of the total farm acreage. The principle of tenancy is recognised as being against good farming. No farmer values someone else's land as his own. Much of the tenancy is found in the south and the west-central States so severely hit by drought and pests.

With this sketchy background it may be possible to visualise something of the urgency and the reason for the force of the New Deal campaign for stability and security of the farmer. From 1933 onward, since President Roosevelt came to power, there has been a series of acts passed by Congress aimed at improving agricultural conditions. These cannot all be mentioned, but some are highly useful examples for us to study. The New Deal policy had three main aims: (1) Reorganisation of the Department of Agriculture. (2) Policy of planned land use. (3) Reduction of farm taxation and prevention of mortgage foreclosure.

In the fulfilment of these plans a great many new duties were given to the Department of Agriculture, for which provision of staff and finance was made, but as the new agencies multiplied there arose some confusion of effort and conflict as to the scope of work. In 1938 the Bureau of Agricultural Economics was given the job of planning a programme of investigation and assistance, and an Office of Land Use Co-ordination created for the purpose of co-ordinating the work of the various sections of the Department in their approach and service to the farmer. This is the body which carries the second item in the programme—planned land use.

Planning land use really developed from two angles. First the policy of land improvement sponsored by the Agricultural Adjustment Administration—the A.A.A. or Triple A.—and secondly, the activity of the Soil Conservation Service in stabilising land against erosion. The main function of the A.A.A. was the limiting of the production of primary products in accordance with the market's demands. Briefly, the Bureau of Agricultural Economics undertakes the work of predicting market requirements in advance and assessing a figure for total U.S. production of certain crops and livestock in the current year. The main crops affected are wheat and cotton—this year tobacco will probably be important also. The A.A.A. then portions out the area for each State concerned with the crop, and it is possible for it to swing production gradually from one part of the country to another on the grounds of greater suitability

of climate or superior quality of product. This can only be done by degrees to avoid the shock to local industry, but the aim is good—namely to concentrate production in the most suitable belts and build up compensating industries in those parts deprived of a staple crop. Each State distributes its quota according to counties, and the county deals with the limiting of its own crops according to its allotment. Up to 1935, the payment made by the Federal Government to compensate farmers for the smaller area planted was taken from a tax on processed primary products such as flour, but on this tax being declared unconstitutional by the U.S. Supreme Court, the later payments have been met from general revenue. There was one change made in policy—the farmer was given a contract with wider obligations. If the taxpayer at large had to pay the farmer, he was entitled to demand a return for his money; since the land is a national asset and therefore everybody's concern, a return could be made by the farmer improving his land as a national asset. The farmer was required to restrict his crop, and to plant or treat the land thereby not used in a manner prescribed by Federal agents. He had then three alternatives: he could perform the full contract of restriction and prescribed management and be paid for it; he could restrict his crop without carrying out any soil building programme, in which case he would not be paid; or he could do neither, in which case he would be penalised by the confiscation of the excess crop. The first course is naturally adopted by the main body of farmers. The point to be noted is that a string is tied to the contract, and the ultimate aim is not only to control the market supply of the crops, but to institute a programme of land improvement—whether it be by prevention of erosion, by the use of legumes or pasture for raising fertility, or by the retirement of unsuitable areas to farm “wood lots”.

The second agency in land use planning is the Soil Conservation Service. This Service was set up in 1936 specifically to tackle the problem of soil erosion and conservation nationally, and in a manner not possible for all individual States. It has worked by advice and active assistance in farm planning, but in particular through soil conservation districts set up, with an advisory staff, at the voluntary request of the farmers of the district. The soil conservation district was organised with a manager and a variety of assistants trained in agronomy, engineering, forestry, etc., according to the nature of the area. The object was to reclaim degenerated portions of the district and make an attack on problems of farm management as they affected soil stabilisation and crop improvement. The soil conservation district permitted soil erosion control to be instituted on a wide scale, with the aid of demonstrations and experiments and the organisation of the whole community on the basis of planned agriculture.

Whatever was done for advancing the farmer and raising his income, equally assisted in keeping him from moving. Security of farm ownership

meant a great deal to a farmer in constant fear of a succession of adverse years, mortgages and possible foreclosure, of being forced into tenancy or finally into share cropping. The evidence seems to show that this was no unusual condition, and a very great problem in many States. There was a way out. The land could be improved in production and rendered secure by development along sound lines made possible partly by A.A.A. payments and partly by loans made through the Farm Security Administration. The latter agency was set up in 1937 for the specific purpose of financing farmers with a genuine case for assistance. The loans are of three types: First, good farmers who have lost their land or are on submarginal land incapable of returning them a living may be lent money to re-establish themselves on a fertile site. There is a requirement that the new farm be handled correctly, and Federal officers have the job of watching the development. Second, farmers might receive loans to allow them to get on their feet again, provided they followed intelligent farm management plans. These loans are on a five-year to ten-year basis at low interest. They were used for buying livestock, implements, fertilisers, and such things that a low income would not allow for effecting improvements. Third, tenant farmers may be assisted by long-term low interest loans to buy farms for themselves. For five years after purchase the Government may resume the farm if it is not used properly, and throughout the period of the loan Federal officers may supervise farming operations.

Another Act passed by Congress authorised the purchase of submarginal land to remove it completely from the market and develop a better use for it. This land is being taken out of poor farms into range grazing land, forests, recreation areas, or other suitable uses. The amounts of money voted for this and the loans to tenant and other farmers are small by comparison with the need. There are 86 million acres of submarginal land in farms, and only 50 million dollars were voted to begin buying it. The numbers of tenant farmers were increasing between 1880 and 1935 at the rate of 33,000 per year; the 50 million dollars in 1939, the largest amount voted for assisting tenant farmers, would not nearly cope with the annual increase if all were to be re-established as landholders. Obviously a proportion would not be worth financing even on supervised farms.

Of all the efforts at improvement, none are more interesting than the community planning sponsored by the land use planning agency of the Bureau of Agricultural Economics. Despite the independent attitude of the farmer, there has come a strong movement towards co-operation, and in at least one country in every State, communities have elected committees to study and plan for the improvement of the district. The committee is essentially made up of farmers with some State or Federal agents acting as advisors. Their object is to work out a scheme for lifting the level of the community, for example by proposing on the agricultural side a more extensive use of fertilisers, or an

increase in the number of high-class bulls, and on the social side, a new road or moving a school site or a rural electrification scheme, or the provision of a recreation reserve. The committee formulates the programme of improvement they would like for the community and, to implement it, may ask for assistance by money loan, cheap electric supply, fertilisers at low rates, or perhaps labour to be done by a Civilian Conservation Corps youths' camp. The community scheme is passed on by the State planning committee, if they are agreeable, to Washington, where it may be accepted or referred back for amendment. The Government, both State and Federal, is keen to help these community committees because the security and stability of the rural population is one of the most urgent problems to be faced. Last year 450 counties had begun community planning within eighteen months of the inception of the movement by the Department of Agriculture so that the future progress of the scheme will be very interesting to follow.

The account given of the activities of Federal agencies set up as part of the New Deal policy has been necessarily sketchy and there are many other aspects which could be discussed. For example, there is the Tennessee Valley Authority's programme of development and rehabilitation in that area touching on seven States, all of which are co-operating. The co-operation of State and Federal research and extension services is a most pleasing sign ; it is a recognition that the brains, as well as money, of the Federal Department can be used to solve national problems within individual States. A Federal Crop Insurance Act, 1938, attempts to insure crop returns to the farmer. The Surplus Commodities Act, 1937-8, provides money for buying crops in excess of the estimated production to prevent gluts and low prices. The Omnibus Flood Control Act, 1936-8, seeks to co-ordinate Federal Government attack on flood problems by bringing in the Department of Agriculture to work with army engineers ; it was the first sensible step in flood control insofar as the problem was tackled at its source in run-off control through land management instead of by building bigger and better levees as in the past. A Water Facilities Act of 1937 provides money for developing water resources in arid and semi-arid regions according to an approved land use programme. From various sources the Secretary of Agriculture is given emergency relief money to preserve wild life, forests, soil, and to control insect pests.

There are a great many critics within and without America of this vast planning programme and public expenditure. Foreign observers often have not quite grasped the size of the country and the extremely serious state it was in. It is all very well to say there is "graft" and misuse of money, that the country cannot go on indefinitely assisting farmers, that the administration does not know where it is heading or when to stop, and that the whole organisation is a pretty example of triumphant and bungling bureaucracy. In the foregoing pages the principle aims and some of the methods of the New Deal

have been described, and undoubtedly good is being done. Some "dictators" have made the statement, somewhat cold-bloodedly, that as the western Dakotas and Nebraska and much of the Dustbowl constitute only range land and have been broken up for wheat by mistake, that they should just simply revert to grass, and the quicker the better. Unfortunately such wholesale programmes are impossible because population cannot be moved *en bloc*. Much of the Texas panhandle is held in 320-acre or smaller areas, and the average carrying capacity of range land is 10 or, on good land, may be 20 beasts per square mile. What then is to be done with say 100,000 farm families who would pass out with the return of the range. Resettle them? And if so, where? Or send them into the towns, and as surely on to relief? The projected plan for the Dustbowl reduces wheat acreage from 19 million to 13 million acres and proportionately alters all other crops while putting the remainder into grass. Ultimately the agricultural system will find its proper balance. It cannot be indefinitely supported by government grants, payments and loans, but if these had not been used in the past five years the critics would have had much more reason to deplore the continuance of the Old Deal. In any case, at least one traveller last year in America found the critics without a plan to substitute.

Surely the way to view the New Deal is as an attempt to save the farmer and the land by the only means that seemed adequate in the desperate condition affairs were reaching in 1934; namely by a huge expenditure of public revenue and loan money. The eyes of the nation are tending to focus on control of land use by Federal or State or other bodies. The people are learning no longer to permit the use of unsuitable and submarginal land in small holdings, and in rural communities the spirit of co-operation to improve farms, incomes, and living in general is stirring. There are many things the farmer can thank the New Deal for, and perhaps the salvation of the farmer in the long view may transcend the mistakes and cost of the great experiment. Australia has not the same problem to face, but there is every need for land use planning and sound development of a *permanent* agriculture. Eyes on America therefore for experience, with a tolerant discriminating judgment.

Grassland Improvement in New South Wales

A SUMMARY OF DEVELOPMENTS AND INVESTIGATIONS

By

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Agrostology, or at least that section of it dealing with the study of agricultural grassland, is the most recently developed of the major agricultural sciences. That the scientific study of grassland is a comparatively new development is rather remarkable considering the economic importance of pastures. It may be explained in part by the fact that pasture plans do not form part of man's food supply directly, but only indirectly in providing the main food supply of his domestic animals. The factors responsible for the increasing scientific interest in the herbaceous sward are the increase in population of many countries, the smaller size of farms, and the demand for earlier maturing food animals. Finally, the discovery that grassland is more responsive to scientific treatment and management than perhaps any other crop encouraged the investigations which now form a prominent feature of the agricultural research programme of every stock producing country.

Development of Coastal and Inland Areas in N.S.W.

For convenience we may divide the history of the coastal or dairying pastures into three definite phases. The pioneering period consisted of the clearing of land, leading to the establishment of native grasses and the sowing of species such as perennial rye, cocksfoot, and clovers. The second phase may be said to have commenced with the introduction of *Paspalum dilatatum* about 1883, and may be referred to as the *Paspalum* era. Few people appreciate the importance of this grass in stabilising the dairying industry. These phases of development were concerned principally with the processes of establishing high-producing grasses on relatively fertile soils. Today we are in the third phase in which a decline is becoming increasingly evident in soil-fertility and pasture production, and it is essential to formulate measures to restore the fertility removed during the two preceding phases. It is complicated by the fact that in many districts the pioneering phase is still incomplete and thousands of acres of country urgently in need of treatment are still carrying dead trees, stumps, and logs.

The development of inland areas depended almost entirely on the capacity of the soils to produce and sustain good native grasses and herbage plants. Exotics, most of them accidental introductions, have played important rôles

and although there are no official records of the introduction of the numerous species of *Medicago* and *Trifolium* for example, these plants, flourishing in our Mediterranean climatic zones, have contributed in no small degree to successful husbandry. Unfortunately they now display a tendency to disappear in some districts; in others their productivity is declining. In inland areas the principal grassland problems are concerned with declining soil fertility and with attempts to transform country intended by nature for the sustenance of nomadic, slow maturing animals, to the demands of modern stock-raising practices such as early lambs and baby beef. The combined effects of droughts, rabbits, and overstocking also have presented a host of problems for solution by the grassland worker.

Early Scientific Investigations.

The earliest work in this State dealt principally with the native pastures from the botanical angle. Workers such as Bentham, Robert Brown, von Mueller, Moore, Maiden, Bailey, Hooker, Betche, Turner and Cheel classified most of the native species and formed the foundation for subsequent economic evaluations. Maiden and Turner, in particular, investigated the economic value of many species, and in their published works, "Manual of the Grasses of N.S.W." (Maiden) and "Australian Grasses" and "Forage Plants of Australia" (Turner), directed attention to various aspects of natural grasslands and their management.

Breakwell carried the work a stage further with studies of exotic species and their cultivation and adaptability to different regions, and other problems. The results of his work are recorded in his "Grasses and Fodder Plants of N.S.W."

As it is obviously impossible to deal in chronological order with modern investigations, it will be most convenient to treat the subject under the headings: species, strain, fertility, and management.

The Plant Species.

The native grasses of N.S.W. are summer growers, providing a low plane of nutrition during the winter months. Denied adequate nutrition during cold weather, stock grazing on them lose condition rapidly; in extreme cases mortality may be high, disease resistance is lowered, and young stock are slow in maturing. In many cases legume association is poor or entirely absent and the ration is often deficient in protein.

The replacement of native species by exotics suited to the conditions and to the requirements of modern stock raising practices demanded critical study of hundreds of plant species under a wide range of soil and climatic conditions. Variations in rainfall from over 60 inches to under 10 inches per annum (and of erratic incidence) and in climate from sub-tropical to alpine increased the complexities of the problem. Nevertheless it is now possible to indicate species suited to the various climatic zones and soil types.

Some 500 different species of grasses, legumes and miscellaneous forage plants have been introduced and tested by the Agrostology Branch of the N.S.W. Dept. of Agriculture. Of these Kikuyu, Sudan grass, *Panicum antidotale*, and various species of Vicia, Medicago and Trifolium have found a permanent place in our agriculture, and others still under test are yielding encouraging results.

Seed Mixture Problems. It was recognised early that the principles followed overseas in compounding seed mixtures did not necessarily apply under New South Wales conditions, that considerably reduced seeding rates could be practised in this State, and indeed were fundamental to successful pasture establishment in many regions. The results of this work were directly beneficial to the farmer as he was able to save from £1 to £2 per acre in establishment costs.

The discovery that lucerne could be grown successfully in districts previously considered too dry for this crop was due in no small measure to decreased seeding rates. This extension of the lucerne belt was followed by an expansion in the area under this crop from 185,881 acres to 486,274 acres in ten years.

Establishment Technique. Problems involving the technique of establishing the various pasture species have been studied under a wide range of soil and climatic conditions. The preparation of seed beds by the use of various implements, optimum conditions for seeding, the use of associate crops, etc., have been the subject of close study. Such matters are more important in the establishment of pastures than in the case of most crops.

The chemical and ecological aspects of plant species studies have dealt mainly with the fodder values of individual species and composite pastures at various stages of growth, and the influence of the grazing animal on the yield, composition, and nutritive value of pastures.

Strain.

It is now acknowledged that the prosperity of a district, or even of a country, is largely dependent on the productivity of its strains of pasture plants. This will be illustrated by two examples. In perennial rye grass a free seeding, early maturing, short lived strain was evolved unconsciously in New Zealand by the practice of sowing and harvesting seed crops of this species year after year. Local farmers, dependent on New Zealand grown seed, practically discontinued using the species because it failed to persist for more than two or three years. Actually it was not the species at fault, but the strain. Upon the introduction of seed certification, a guarantee was given that the seed was taken from old established pastures of persistent, leafy plants, and rye grass rapidly re-established itself in public favour. Cocksfoot at one time was exceedingly popular with local farmers, but went out of favour simply because of the poor strain of most commercial seed. The type most

commonly purchased by farmers was the Danish, which was short lived, with a high proportion of stalk and a correspondingly low proportion of leaf. The advent of certified Akaroa type cocksfoot, which is more persistent and has a high proportion of fine leafage, enabled the species to regain popularity.

The selection of strains has been a major study during the past decade. As well as testing some one thousand imported strains of perennial rye, cocksfoot red and white clover, lucerne and miscellaneous species, regional ecotypes have been isolated within the State and tested. Naturalised strains of perennial rye, cocksfoot, white clover and subterranean clover have been critically examined in comparison with the best imported strains. The greatest drawback to a wider exploitation of local strains is the absence of an organised seed industry.

Soil Fertility.

As previously mentioned, many of our grassland problems are intimately concerned with soil fertility. There is a popular but ill-founded belief in this State at least that Australia is a land of almost limitless soil resources. In pasture improvement work it is an accepted principle that the soil fertility must conform to the requirements of the species it is desired to grow. Since the heavier yielding species are those that make the greatest demands on soil fertility, the importance of maintaining a high standard of fertility is fairly obvious. The first systematic investigations with fertilisers were commenced on both natural and sown pastures during 1920, most of the commonly used fertilisers being tested. Early conclusions favoured the use of those supplying nitrogen in liberal amounts as they invariably gave a profuse leaf production from the grasses. It was realised, however, that the high cost of nitrogen precluded its use on a large scale or on big paddocks where a considerable proportion of the food produced was wasted. At the same time it was known that phosphoric acid was particularly deficient in most New South Wales soils, and in 1923 it was observed that where superphosphate had been used a profuse growth of clover resulted.

It was at this juncture that the first inkling was obtained of the true value of superphosphate as the fertiliser forming the basis of soil fertility maintenance and improvement. From this point numerous investigations were conducted until gradually the story was more or less completed—the stimulation of clovers, nitrogen accretion, the increase in the mineral content of pasturage, and the influence of treated pastures on the health of stock. Many subsidiary issues were involved, such as the effects of various rates, frequencies and methods of application in numerous districts, the influence of treated pastures on wool quality, and the problem of non-responsive soils.

Spectacular results following application of superphosphate to grazing lands in wheat areas were to a considerable extent responsible for farmers and graziers adopting the methods of increasing the productivity of their grasslands.

Let figures complete this brief summary. In 1927, 19,314 acres of pastures were topdressed; by 1938 the area treated had increased to 875,730 acres.

Management.

No scheme of pasture improvement can be entirely successful in the absence of efficient management. Early workers such as Turner recognised the necessity for closer subdivision of our natural pastures and directed attention to the ill effects of continued overstocking and understocking. With the advent of improved pastures the need for systematic methods of management soon became apparent.

Under this heading may be included the efficient utilisation of pastures, conservation of surplus pasturage, grassland renovation, subdivision of paddocks and the use of the mower. It has been necessary to study the effects of overgrazing and undergrazing on the permanency and species composition of the sward, and on the nutritive qualities under various systems of management efficient and inefficient.

The erratic nature of our rainfall is responsible for a very uneven seasonal curve of growth from pastures. Unless adequate reserves of conserved fodder are available, stock suffer from under-nutrition at certain periods, whilst at others it is impossible to control the growth at peak periods of production with the normal complement of grazing animals. Stock may again be undernourished by being compelled to graze on over-mature growth. *Paspalum dilatatum* pastures furnish an excellent example of the extreme changes which may occur in the growth and nutritive value of pastures as a result of seasonal variations. It has been necessary to study the technique of converting surplus material into hay and silage and the most convenient methods of feeding it to stock.

Grassland renovation is a particularly important phase of management to dairy farmers dependent on *paspalum* pastures. About 15 years ago it became evident that these pastures were failing to produce the results formerly characteristic of them. Treatment with fertilisers having failed to produce worthwhile results, drastic mechanical treatments were tested to relieve the obvious sod-bound conditions of the swards. The solution to this problem was ultimately found in the use of ploughs, and implements specially designed for *Paspalum* renovation, together with appropriate measures to increase soil fertility.

Whilst it was recognised that subdivision of paddocks was fundamental to efficient management, no precise information was available in early days regarding unit areas. As the result of a considerable investigation, it is now possible to instruct farmers regarding this very important phase of management.

The Future.

The gross value of the products of the pastoral and dairying industries for the year 1937 was in the vicinity of £56,000,000. Any improvement in

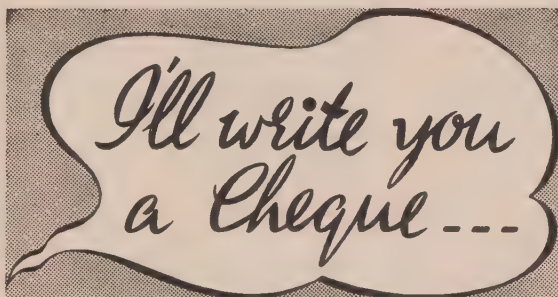
production from grassland must reflect itself, therefore, upon the national wellbeing. The achievements of advisory workers in inducing landowners to adopt improved methods are shown in the increases recorded in the areas of sown pastures, topdressed pastures and lucerne, and by the spectacular increases in carrying capacity obtained by many graziers. The increased scope for future advisory work is shown by the fact that the present stock population in the area of 53,479,457 acres of grassland in the coast, tablelands and slopes divisions, climatically suitable for improvement, expressed in terms of sheep, is less than one sheep per acre, a figure which compares most unfavourably with the results of individual landowners who have adopted pasture improvement. There is no doubt that this average could be appreciably increased. Apart from increased carrying capacity, there are other matters of almost equal importance demanding the attention of advisory officers, such as the uneven plane of production of, for example, butter and fat lambs, and the ailments of sheep that are directly traceable to pasture deficiencies.

Grassland improvement has already played a conspicuous part in determining land values in certain districts and is gradually modifying old concepts regarding carrying capacity, living areas and closer settlement. Land seekers now buy "rainfall" rather than soil, with the result that land values in safe rainfall zones suitable for sheep raising have in many cases more than doubled in recent years. The "small area" concept is gaining ground in country districts with the realisation that production from a small area intensely worked can be greater than from a large area inefficiently managed. This radical change will ultimately be reflected in land settlement policies.

On the technical side it is interesting to forecast the probable developments of the near future. "Strain" will undoubtedly be an important factor in stabilising pasture production in marginal rainfall areas and in raising the production "peak" in safe areas.

At the moment the maintenance of soil fertility devolves almost entirely on the use of superphosphate. In some cases we are finding that lime is essential and that nitrogenous fertilisers can be used profitably. It can be anticipated, however, that in the course of time it will be necessary to study more closely the rôle of potash and perhaps some of the minor elements.

Another important aspect of future work will be that dealing with grassland management and animal nutrition. To date we have been concerned mainly with the production of better pastures, but indications point to the necessity for improved methods of utilising them. Farmers have already found it necessary to supply materials containing a high percentage of fibre to animals grazing on succulent pastures. In the past our main problems have been concerned with under nutrition; in the future, problems associated with unbalanced nutrition will require close attention.



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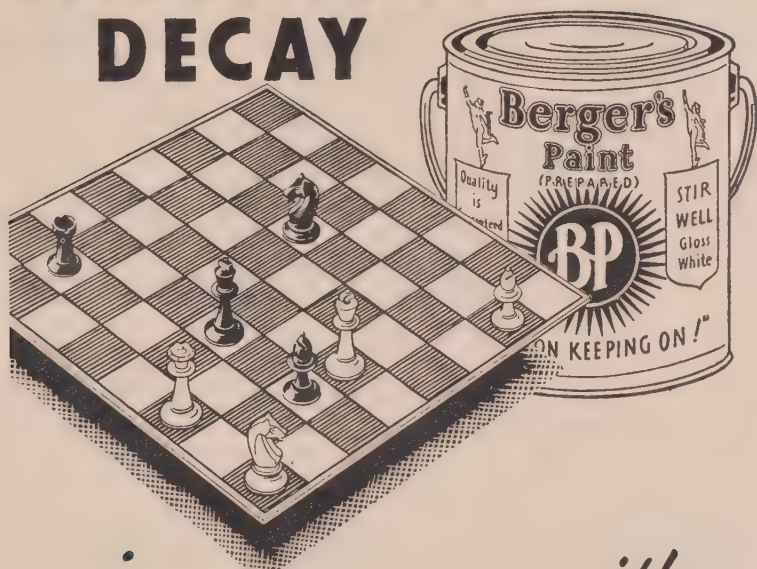
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The Biological Antagonism of *Gibberella fujikuroi* and *Gibberella fujikuroi* var. *subglutinans* to *Trichoderma viride*,

WITH NOTES ON THE PATHOLOGICAL EFFECTS
OF THE LATTER FUNGUS ON MAIZE

By

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Introduction.

During the course of investigational work at the University of Wisconsin on the relation of various environmental factors to the seedling blight diseases of maize caused by *Gibberella fujikuroi* (Saw.) Wr. and *Gibberella fujikuroi* (Saw.) Wr. var. *subglutinans* Edwards, an interesting case of biological interaction was observed between these organisms and *Trichoderma viride* (Pers. ex Fries) Bisby.

It is not proposed to give any general account of the phenomenon of biological antagonism or other association effects of microorganisms, as two excellent review papers have been published by Porter and Carter⁽¹⁸⁾ and Weindling.⁽²³⁾ It is desired, however, to place on record the ability of *G. fujikuroi* and *G. fujikuroi* var. *subglutinans* to inhibit the growth of *T. viride* and to call attention to the ability of this fungus to induce pathological effects in maize seedlings.

Weindling^(21, 22) has demonstrated the marked antagonism of *Trichoderma lignorum* to a number of important fungous plant pathogens, including *Rhizoctonia solani*, *Phymatotrichum omnivorum* and several species of *Helminthosporium*, *Fusarium* and *Pythium*. Waksman and Foster⁽²⁰⁾ have shown also that *T. lignorum* retards or inhibits the growth of a wide variety of fungi and bacteria, both in pure culture and in the soil. In view of the findings recorded in the present paper it is interesting to note that these authors also report that one isolate of *Actinomyces* was actively antagonistic to *Trichoderma* itself and inhibited its development by the production of some specific substance in the medium. Bisby⁽¹⁾ has recently given detailed consideration to the mycological and taxonomic aspects of *Trichoderma* and concludes that it is a monotypic genus. *Trichoderma lignorum* and *T. Koningi* (which will be mentioned later) are therefore synonymous with *T. viride*.

* Commonwealth Fund Service Fellow, Department of Plant Pathology, University of Wisconsin, Madison, Wisconsin, U.S.A., 1937-39.

The findings recorded herein resulted from a consideration of certain aberrant results that the writer obtained during a comprehensive study of the relation of soil and air temperature, soil moisture, mineral nutrition, kernel size and seed treatment to the development of seedling blight in maize arising from internal seed-borne infection and external grain inoculation with *G. fujikuroi* and *G. fujikuroi* var. *subglutinans*. Studies were also made of the effect of these various factors on seedling vigour.

During the course of this work many thousands of maize seedlings were grown and subjected to careful examination. In all cases the disease reaction was determined by means of an infection index based on the recognition of six infection classes, whilst the records of seedling vigour were based entirely on dry weight determinations. The results of these studies will be published elsewhere and will not be discussed at the present time except insofar as it is necessary for an understanding of the data presented herein.

The investigations showed that a soil temperature of 18-20° C. was the optimum for seedling blight development. At lower temperatures a considerable amount of defective germination and pre-emergence killing occurred, but at these temperatures the controls likewise showed a reduction in germination capacity. When seedlings were grown at constant soil temperatures above 24° C. considerable injury to the subcrown internode and adventitious roots commonly occurred. This injury was apparently a direct temperature effect and was independent of inoculation or of the chance presence of any pathogenic organism.

The Phenomenon of Apparent Growth Stimulation.

True seedling blight infection did not occur at temperatures above 24° C., but at this temperature and above, it was surprising to find in an appreciable number of cases that the seedlings derived from inoculated or infected kernels made better growth and were considerably more vigorous than the corresponding controls raised from uninoculated seed or seed known to be free from internal fungous infection. These differences in vigour were apparent by inspection and were also clearly shown by the dry weight determinations. (Table 1.)

It was at first thought that the increased vigour of the seedlings derived from inoculated or infected grain might be due to the action of a growth stimulatory substance produced by the fungus, since it has been known for many years that inoculation with the strains of *G. fujikuroi* responsible for the "bakanae" disease of rice in Oriental countries had a marked stimulatory effect on the growth of the young seedlings.

Various workers, including Hemmi and Seto,⁽⁹⁾ Ito and Shimada,⁽¹⁰⁾ and Kurosawa⁽¹²⁾ have shown that this growth stimulation of rice seedlings

TABLE I.

Mean dry weight determinations of maize seedlings from mineral nutrition experiments conducted at 28° C., showing the adverse effect of *Trichoderma viride* on growth of seedlings derived from grain free from *Gibberella* infection or inoculation.

Nutrient Series.	Condition of Grain Used for Seed.	Milligrams of P, K or N per 100 ml. of added nutrient solution.				
		0	10	25	75	150
Phosphorus nutrition experiment.		Average Dry Weight in Grams.				
	Infection-free control	0·148	0·125	0·155	0·127	0·134
	Internal infection with <i>G. fujikuroi</i>	0·202	0·169	0·191	0·201	0·177
	Internal infection with <i>G. fujikuroi</i> var. <i>subglutinans</i> ..	0·165	0·198	0·168	0·156	0·136
Potassium nutrition experiment.	Uninoculated control	0·207	0·182	0·215	0·264	0·212
	External inoculation with <i>G. fujikuroi</i>	0·238	0·230	0·234	0·263	0·233
	External inoculation with <i>G. fujikuroi</i> var. <i>subglutinans</i>	0·208	0·260	0·244	0·274	0·277
		0·119	0·183	0·195	0·118	0·126
Nitrogen nutrition experiment.	Uninoculated control	0·119	0·183	0·195	0·118	0·126
	External inoculation with <i>G. fujikuroi</i>	0·125	0·214	0·219	0·195	0·158
	External inoculation with <i>G. fujikuroi</i> var. <i>subglutinans</i>	0·142	0·200	0·182	0·225	0·149

The mean weights are based on the growth obtained from 40 seeds sown at each level of nutrient supply. Mean weight comparisons are not valid between the three nutrient series, as the P, K and N experiments were not necessarily conducted at the same period, nor for the same length of time.

could be induced also by filtrates of certain culture media in which the fungus had been grown. Nisikado and Matsumoto⁽¹⁷⁾ have shown that the "bakanae" fungus likewise produced an abnormal elongation in seedlings of maize, sorghum, barley, sugar cane and *Panicum miliaceum*. De Haan⁽⁴⁾ also has reported that inoculation with *G. fujikuroi* frequently stimulated seedling growth of maize, barley, oats and rice, although stimulation was not shown by all the varieties tested, nor was it always apparent at all temperatures. The writer,⁽⁶⁾ in 1935, discussed the possible production of a growth stimulatory substance by *G. fujikuroi* var. *subglutinans* and showed that maize kernels partially rotted with this fungus commonly germinated *in situ* prior to the maturation of the ear. It was found also in germination tests at 25° C. that the partially rotted grains germinated very much more rapidly than did unaffected mature kernels from the same ear.

Despite the observations made by these various workers, there is still no biochemical proof that either *G. fujikuroi* or *G. fujikuroi* var. *subglutinans* actually produces any growth stimulatory substance.* Moreover, in the work conducted by the writer at the University of Wisconsin it was shown that the growth differences between the control and inoculated maize seedlings were due to other causes.

* Since going to press it has been found that Yabuta and Hayashi (Jour. Agr. Chem. Soc. Japan, 15: 257-266, 1939; Rev. App. Mycol., 18: 707-708, 1939) have reported the isolation in a crystalline state of "gibberellin", the growth stimulatory substance of the "bakanae" fungus *G. fujikuroi*.

Antagonistic Effects of *Gibberella* and the Rôle of *Trichoderma*.

The first intimation that factors other than growth promoting substance might be responsible for the growth differences of the control and inoculated seedlings was obtained in a series of experiments designed to show the relation of five levels of phosphorus nutrition to the development of seedling blight. This experiment involved 120 pots of washed, sterilised quartz sand each sown with 10 grains of Golden Glow maize. Half the pots were maintained at an air temperature of 20° C. and the remainder at 28° C. One-third of the pots at each temperature were sown with grain known to be carrying not less than 92 per cent. internal infection with *G. fujikuroi*, one-third with grain similarly infected with *G. fujikuroi* var. *subglutinans*, and the remaining third with grain which showed not more than 7 per cent. total internal fungous infection. Each pot received 100 ml. of nutrient solution three times per week, together with applications of distilled water whenever necessary to prevent drying out.

In the series maintained at 28° C. it was found that there were very striking differences between the vigour of the control seedlings and those derived from infected grain (Table 1). Each of the 20 control pots, irrespective of nutrient treatment, produced seedlings that were markedly stunted and uneven in growth, and which also commonly showed chlorotic streaks at the base of the leaves (Fig. 1). As the experiment progressed a number of control seedlings wilted or died. On the other hand, seedlings derived from the infected kernels made excellent growth, and were tall and uniformly vigorous and of an excellent dark green colour (Fig. 2).

When the experiment was harvested it was found that in every case the germinated kernels of the control seedlings were badly rotted and overrun with *T. viride* (Fig. 3) and frequently sand balls of considerable size, which were held together by fungous hyphae, adhered to the rotting kernels as the seedlings were removed from the pots. Most of the seedlings showed more or less severe rotting of the basal portion of subcrown internode adjacent to the kernel, and frequently the roots were also lesioned (Fig. 1). The lesions were light brown in colour and watersoaked in appearance, and commonly *Trichoderma* was growing and sporulating abundantly on the surface of the rotted areas.

When the seedlings grown from the infected kernels were harvested it was found that in about 90 per cent. of cases the seed coats of the germinated kernels showed the reddish or purplish discolorations characteristic of internal seed-borne infection with *G. fujikuroi* or *G. fujikuroi* var. *subglutinans*. Each seedling was examined carefully but no trace of *T. viride* was found either on the germinated kernels or on the subcrown internode, even though the cortical tissues of the latter were commonly injured owing to constant high temperature. In every pot, however, *T. viride* occurred on the basal watersoaked portion of the wooden identification label, thus indicating that it was widespread

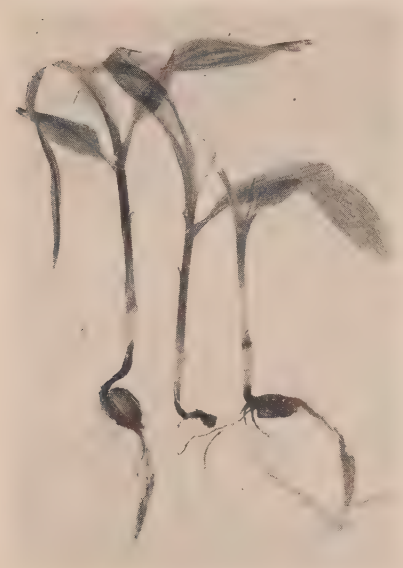


Figure 1.

Maize seedlings derived from Gibberella-free grain, showing the characteristic injury resulting from rotting of germinated grains, subcrown internodes and roots due to *Trichoderma viride*. Seedlings grown in sand nutrient series at 28° C.



Figure 2.

Maize seedlings derived from Gibberella-infected grain and grown in sand nutrient series at 28° C. Note absence of injury to subcrown internode and roots, and the general vigour of seedlings.



Figure 3.

Germinated grains of Gibberella-free maize from sand nutrient series at 28° C., showing extensive rotting caused by *Trichoderma viride*. Note abundant mycelial development and cementing of quartz sand to kernels.

throughout the greenhouse, and had failed to develop only on the Gibberella-infected material.

Extensive isolations on water agar and on potato dextrose agar were made from root lesions and the rotted areas on the subcrown internodes of the control seedlings, and *T. viride* was obtained in nearly all cases, although it was often contaminated with bacteria. *Gibberella fujikuroi* was also isolated a number of times. In a few cases *T. viride* and *G. fujikuroi* were isolated from the same piece of tissue, and invariably where this occurred the Trichoderma outgrew the latter fungus and only sporulated in the zone outside the central area where the Gibberella occurred. Direct transfers of the mycelium and spore material, present on the surface of the rotted kernels yielded *T. viride* in every instance although it was usually contaminated with bacteria.

Isolations from injured subcrown internodes of seedlings raised from Gibberella-infected grain yielded mixtures of bacteria and *G. fujikuroi* or *G. fujikuroi* var. *subglutinans*, but in no case was *T. viride* obtained from such material. The injury to the basal tissues of maize seedlings grown at high temperatures is quite distinct from that caused by true seedling blight infection, and the Gibberella isolated from the heat-injured tissues apparently functioned as a saprophyte only.

Concurrently with the phosphorus nutrition experiment, a similar experiment to determine the effect of potassium nutrition on seedling blight development was conducted in the same green-houses. In this case, however, the variety of maize was Funks Yellow Dent and the seed was inoculated externally by soaking for half an hour in a conidial suspension of either *G. fujikuroi* or *G. fujikuroi* var. *subglutinans*. The inoculated seed was then germinated in porcelain trays at the same temperatures at which the seedlings were to be grown in the greenhouse, and were atomised daily with fresh conidial suspensions in sterile water until the coleoptiles were about $\frac{1}{2}$ to $\frac{3}{4}$ of an inch in length. The germinated grains were then transferred to pots of washed sterilised quartz sand.

In this experiment also the inoculated seedlings grown at 28° C. made considerably better growth than did those derived from uninoculated seed. Likewise, in many of the control seedlings the germinated grains were again badly rotted with *T. viride* and there was also considerable lesioning of roots and subcrown internodes, although in general the seedlings were not injured as severely as in the Golden Glow phosphorus series.

Isolations from the control seedlings again yielded *T. viride* in practically every case, although a few cultures of *G. fujikuroi* and *Penicillium* sp. were also obtained in addition to bacteria. None of the inoculated seedlings showed any trace of Trichoderma, and isolations mainly yielded the Gibberella used as inoculum although a great deal of bacterial contamination occurred.

In a potassium nutrition experiment conducted in the 20° C. greenhouse with internally infected and nearly infection-free seed of Golden Glow maize, essentially the same type of phenomenon was encountered and the control seedlings were injured to such an extent that the infection indices were of the same order as those for the *Gibberella*-infected material. In this case, however, isolations showed that the principal fungus occurring on the germinated control grains and subcrown internodes was *Penicillium* sp. *Trichoderma viride* was also isolated, but it was not as prevalent as the former organism. An occasional seedling amongst those grown from infected seed also showed the presence of *Penicillium* sp., but this occurred only rarely and it is probable that these particular kernels were not infected internally with *Gibberella*.

The phenomenon of the seedlings from *Gibberella*-infected or inoculated seed showing a more vigorous growth than did the corresponding controls was commonly observed when the seedlings were maintained at a temperature of 28° C. In addition to the instances already recorded, the phenomenon occurred in one of the nitrogen nutrition experiments and also in some of the general infection experiments conducted at 28° C. In most cases, however, the growth differences between the inoculated and control seedlings were not so great when the plants were grown in soil as they were in the sterilised quartz sand. However, in all cases where the phenomenon occurred at high temperatures, investigation showed that *T. viride* was associated with the unsatisfactory growth of the control seedlings.

With few exceptions, all the infection experiments carried out in the 20° C. greenhouse or in soil-temperature tanks maintained at this temperature, behaved in a normal manner and the seedlings raised from non-infected or uninoculated grain were markedly superior in stand and vigour to those produced from *Gibberella*-infected or inoculated seed.

In a few instances where aberrant results were obtained at 20° C., such as occurred in the potassium nutrition experiment recorded herein, it was found that the control seedlings had been injured by *Penicillium* sp. or by chance infection with one or other of the organisms used as inoculum.

The profuse development of *T. viride* on the germinated kernels that were free from *Gibberella* infection, and its complete absence on the infected or inoculated kernels at 28° C., indicated an antagonistic relationship between the two types of *Gibberella* and the *Trichoderma*.

A limited number of experiments was conducted on solid media to see if such a relationship could be demonstrated in culture, but no positive results were obtained. In addition, a number of surface sterilised kernels infected internally with either *G. fujikuroi* or *G. fujikuroi* var. *subglutinans* were placed in petri dishes of sterile water and germinated at 28° C. Four or five days after germination 1, 3, 5 and 10 ml. lots of liquid were drawn off from each

lot of germinated grain and mixed with potato dextrose agar in a series of petri dishes. Similar amounts of liquid were removed from dishes in which non-infected grains had germinated, and were incorporated in dishes of potato dextrose agar to serve as controls. All dishes were inoculated with a uniform amount of a mixed mycelial and conidial suspension of *T. viride* and incubated at 28° C. The fungus made excellent growth in all series, and no cultural differences could be distinguished as a result of any treatment. When placed in small amounts of the solutions in which the three types of grain had been germinated, the conidia of *T. viride* germinated equally well in all solutions at a temperature of 25-26° C.

Discussion of Antagonistic Effects.

It has not been possible to do any further work on the nature of the biological interactions recorded herein, but the observations show that under certain conditions at least the presence of either *G. fujikuroi* or *G. fujikuroi* var. *subglutinans*, either in or on germinating maize kernels, will prevent the development thereon of either *T. viride* or *Penicillium* sp.

The mechanism of this inhibition is unknown, but it may be due to specific substances that exude from the germinated Gibberella-infected kernels. That exudations commonly occur from germinated maize grain is shown by the manner in which quartz sand in the vicinity of a Gibberella-infected kernel will be stained with the reddish purple discoloration that is characteristic of such infection in germinating maize. On the other hand, it is possible that the action of the Gibberella on the decomposing kernel tissues renders them unsuitable for the subsequent growth of Trichoderma or Penicillium, owing to changes in pH or in chemical composition.

The ability of certain fungi that are pathogenic on maize to produce antibiotic substances has been clearly demonstrated by Melhus^(14, 15, 16) and his co-workers, who found that soaking Diplodia-infected maize kernels in extracts of aged cultures of *Diplodia zeae* materially reduced the amount of seedling blight that occurred when the treated grains were sown under conditions favourable for blight development. The inhibitory principle has been obtained also from water extracts of Diplodia-infected maize meal. It was found also that other organisms, such as *Aspergillus niger*, *Gibberella zeae* and *G. fujikuroi*, produced substances which likewise exercised an inhibitory effect on the development of Diplodia seedling blight.

Davis and Porter⁽³⁾ showed that the germination of barley seeds infected with *G. zeae* was increased appreciably by presoaking for 12 hours in filtrates from cultures of *G. zeae*, *G. fujikuroi*, *Diplodia zeae*, *Aspergillus niger* and *Helminthosporium gramineum*. With one exception, the treatment of disease-free seeds with such filtrates caused a reduction in germination capacity.

Diachun⁽⁵⁾ studied the interaction of several species of *Penicillium* in the production of injury to maize seedlings and showed that the inoculation of wounded kernels with *P. notatum* or with *Penicillium* sp. partially protected the grain from soil-borne infection with *P. oxalicum*.

Possible Significance of *Trichoderma viride* as a Plant Pathogen.

It appears that little attention has been paid to the possible pathogenicity of *Trichoderma* on higher plants, although its effect on other microorganisms has been studied rather extensively.

Crabill⁽²⁾ reported that *Trichoderma Koningi* was responsible for a destructive root rot of apples in Virginia, U.S.A. Simmonds and Ledingham⁽¹⁹⁾ found that *T. Koningi* was virulently pathogenic to wheat seedlings in laboratory tests. Gregory⁽⁸⁾ records that *T. viride* was commonly associated with bulb rot of narcissus. Matsumoto⁽¹³⁾ has recently reported on a *Trichoderma* root rot disease of roses, crotons and other plants in Formosa that appears to be very similar to Crabill's root rot of apples.⁽²⁾

The pathological effects produced on maize seedlings by *T. viride* are of particular interest as no previous record of such injury has been found in the literature. It is not known, however, whether this injury is due to active parasitism of *Trichoderma*, or whether it results from the action of toxic substances produced by the fungus after it has become established as a saprophyte on the germinated maize grain. In this connection it is pertinent to note that in the case of injury to maize seedlings caused by *Penicillium oxalicum*, it has been shown by Johann, Holbert and Dickson⁽¹¹⁾ that the pathological effect is due to the production by the fungus of oxalic acid and its subsequent absorption by the plant.

Trichoderma viride is occasionally associated with kernel rot of maize and it also occurs rather infrequently as an internal seed-borne organism. In the course of a survey made by the writer⁽⁷⁾ to determine the nature and incidence of internal grain infection and kernel rot in the 1938 American maize crop, *T. viride* was isolated from samples produced over a wide geographical range, but it was most prevalent in grain from Iowa, Minnesota, Nebraska and Maryland. It has also been found associated with ear rot of maize in New South Wales, and on a number of occasions has been found on segments of old maize stalks remaining in the field between seasons.

Summary.

1. A type of biological interaction has been described whereby the growth of *Trichoderma viride* is inhibited by the presence of *Gibberella fujikuroi* or *Gibberella fujikuroi* var. *subglutinans*.

2. At 28° C. maize seedlings derived from grain internally infected or externally inoculated with either of the latter organisms, commonly showed an

apparent growth stimulation and a higher mean dry weight than did the control seedlings.

3. These growth differences were not due to the action of any growth stimulatory substance produced by the fungi, but resulted from the deleterious effect of *T. viride* on the seedlings raised from seed free from *G. fujikuroi* or *G. fujikuroi* var. *subglutinans*.

4. The pathological effects of *T. viride* on maize seedlings have been described and the possible rôle of this fungus as a plant pathogen has been discussed.

Acknowledgments.

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TECHNICAL NOTES

A CAPSID PLANT BUG ATTACKING STONE FRUITS.

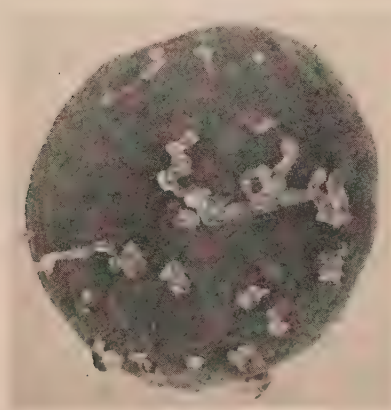
In the early part of this year, severe damage to stone fruits was observed at Baarmutha in the north-eastern district of Victoria. The insect responsible for the condition was a plant bug, belonging to the family Miridæ (Capsidæ), *Megacælum modestum* Distant.

The members of the family Miridæ (Capsidæ) are on the whole injurious insects, being pests chiefly of crops, grasses and fruit trees overseas. The apple Capsid bug, *Plesiocoris rugicollis* Fall., is possibly the most dreaded pest of apples in England at the present time.⁽¹⁾

In Australia, very little, if any, damage to crops by pests of this group has hitherto been recorded, although in New Zealand the introduced species, *Stenotus binotatus* Fabr., is reported as causing considerable damage to introduced grasses.⁽²⁾ On the other hand, several species of this family have been recorded as egg parasites of destructive insects, the species *Cyrtorhinus mundulus* Bred. being an egg parasite of *Perkinsiella* sp. in Queensland, whence it was introduced to Hawaii with great success.

The species *Megacælum modestum* was described by Distant in 1904⁽³⁾ from specimens purchased by the British Museum from the collection of F. P. Dodd and collected, presumably, at Townsville, Queensland. No information is available as to the host plant on which this species was originally collected.

Mr. J. H. Smith, Senior Research Officer, Department of Agriculture and Stock, Brisbane, reports that this species is only of minor importance in Queensland on cotton, potatoes, beans, peas and lucerne, but not on fruits.



Gumming of Elberta Peach caused by *Megacælum modestum* (north-east Victoria, Jan., 1940).

In New South Wales, in 1939, a plant bug, *Dicyphus* sp., was recorded as attacking peaches and nectarines.⁽⁴⁾ It now appears that the insect responsible for this damage is identical with the species recorded here in Victoria on stone fruits, and should now be referred to as *Megacælum modestum* Distant.

The genus *Megacælum* is also poorly represented in literature. The species *Megacælum beckeri* Fieb. is recorded by Myers⁽⁵⁾ as being a member of a very interesting complex on young pear shoots, while the species *Megacælum esmedoræ* was described by Ballard⁽⁶⁾ on *Melia azadirachta*. In addition, *Megacælum stramineum* Walk. is recorded by Ballard⁽⁷⁾ as being a pest of *Andropogon sorghum* in Madras.

At Baarmutha, cherries, nectarines and peaches were attacked by this plant bug, the most serious damage resulting to late peaches of the Elberta type. Up to the present, there is no evidence to suggest that apples and pears are attacked. Damage is caused by the adult insect feeding on the fruit, as many as six adults being found on the one fruit. Feeding usually takes place in sheltered positions, where two fruits touch, where a leaf rests on a fruit, or between a fruit and the stem. The puncturing of the flesh of the fruit is deep-seated, the punctures being deeper and more numerous than those caused by the Rutherglen bug, *Nysius vinitor* Berg. With varieties of peaches other than Elbertas, the damage is apparent on the fruit in the form of dark spots on the skin, beneath which will be found brown corky areas. When the fruit is attacked early, growth at these points of feeding is stopped. With the Elberta variety, however, severe gumming on the surface of the fruit occurs, the fruit finally dropping. Every fruit on a tree may be affected to the extent, shown in the accompanying illustration. As far as could be observed, no damage was caused to the foliage on young shoots.

Insecticidal control of this insect is difficult on account of the sheltered positions in which the insect feeds, and its habit of flying away when disturbed.

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SAMPLING OF OATS FOR GREEN FEED AND THEIR RECOVERY AFTER GRAZING.

There is a need in the drier cereal districts for the development of suitable grazing plants. Considering ease of establishment, palatability of fodder produced, and recovery after successive grazings, there are no pasture species, as yet, that can surpass oats. Trials to compare oat varieties for grazing have been in progress at the Mallee Research Station, Walpeup, since 1935. These have demonstrated, *inter alia*, that early varieties (Mulga or Belar) give most early feed; late varieties (Algerian or Algeribee) give most late feed; while a mid-season type (Dawn) gives the greatest total amount of feed during the whole season. Details will be presented in a more complete article to be published in the *Victorian Journal of Agriculture*.

Several technical points have arisen out of the investigations that should be of particular interest to readers of this Journal.

Measurement of Fodder Consumed.

In order to obtain an estimate of the growth of green fodder, and of the amount eaten at each grazing, some method of sampling the oats was necessary. The unit size of sample adopted was an area 28 inches by 18 inches (i.e. four drill rows, 18 inches long) and 25 such samples were taken on an organised scatter over the plot. Sampling was done both before and after grazing. Careful records of grazing were also kept, the plots being sufficiently large ($\frac{1}{2}$ – $\frac{3}{4}$ acre) to give a reliable estimate of the carrying capacity.

Correlations between these two yield estimates ("sampling" and "sheep-days") were obtained by an analysis of covariance in which the effect of time of grazing and variety was eliminated. The following correlation values were obtained.

Year.	Correlation between "Before-grazing" Sampling and "Sheep- days".	Correlation between Actual Amount Grazed (by "Sampling"*) and "Sheep-days".
1935	+0.48 ± 0.069	+0.5 ± 0.059
1936	+0.54 ± 0.051	+0.53 ± 0.051
1937	+0.77 ± 0.045	+0.67 ± 0.062

* Actual amount grazed is the difference between the amounts estimated by sampling before and after grazing.

From the above it will be seen that the correlation values in any one year are approximately equal, thereby indicating that the single "before-grazing" sample was as reliable as the "actual grazing" estimate. This is probably due

to the fact that the plots were grazed hard at each grazing. In later work it was decided from this evidence to restrict the sampling to "before-grazing."

Importance of Phasic Development.

The extent of the recovery of an oat crop, after an early grazing, is dependent largely on the spring rainfall; but, within any one maturity group, the varieties that recover to the greatest degree after grazing are those having a long pre-jointing and a short post-jointing stage.

TABLE I.—*Comparison of Length of the Pre-jointing Stage and Recovery Power of Oat Varieties.*

Average of three years (1937-1939).

Variety.	Germination to Jointing.	Jointing to Heading.	Grain Yield Ungrazed.	Grain Yield Grazed.	Ratio Grazed Yield to Ungrazed.
	Days.	Days.	Bush. per Acre.	Bush. per Acre.	%
<i>Early varieties.</i>					
Mulga ..	80	39	21.6	11.0	51
Gidgee ..	88	33	21.3	12.1	57
Palestine × Dawn R4-1-1	91	29	26.4	16.4	62
<i>Mid-season varieties.</i>					
Dawn ..	88	39	21.3	9.6	45
Guyra ..	92	35	24.3	10.7	44
Fulghum ..	99	28	21.9	16.4	75
<i>Late varieties.</i>					
Algeribee ..	97	37	21.6	10.6	49
Algerian ..	103	33	21.8	10.9	50
Ideal ..	110	19	23.2	13.5	58

Thus, when oats are to be grown for early grazing and then allowed to recover for a grain yield, varieties with a long rosette stage (germination to jointing) should be chosen. The two standard varieties Fulghum and Ideal, which are known to recover well, demonstrate this point, while the crossbred Palestine × Dawn R4-1-1 shows definite promise as an early maturing variety for this purpose also.

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OBSERVATIONS ON THE TOXICITY OF SOME INSECTICIDES AS STOMACH-POISONS TO BLOWFLY MAGGOTS.

During the period 1930-36, in connection with an endeavour to devise improved jetting mixtures for application to sheep for protection against blowfly strike, an attempt was made to determine the relative toxicities as stomach-poisons of a number of insecticides, either well known or of possible utility. The first standard considered was the power of the substances when incorporated in minced meat to prevent the development of maggots in the meat. Hatching eggs or larvæ one to four hours old, were placed on a series of meat samples containing varying quantities of the insecticides. The lowest concentration in which no larvæ reached pupation and the highest at which some larvæ pupated were noted for many of them, and the concentration at which full development was just prevented was considered to be between the two. But for some substances this lethal concentration was merely noted as being above or below a certain limit. *Lucilia cuprina* was used in the majority of the tests, but in some the larvæ of *L. sericata* or *Calliphora stygia* were employed.

A summary of observations is set out in Table 1.

The meat was fresh lean beef steak finely minced. Concentrations of poisons in it, ranging from 100 to 200,000 parts per million, were made by stirring in required quantities of solutions or suspensions or, in some cases, weights of dry powders or of oils. For suspensions, 15- to 50-gram portions of meat had added to them 1- or 2-millilitre volumes of suspensions of such concentrations as would give the required range of concentrations in the meat. The 1- or 2-millilitre quantities were obtained by agitating the bulk sample of suspension and, in the process, filling 1- or 2-millilitre pipettes. For solutions, 20-gram lots of meat were used with appropriate quantities of solution. For all lots of meat, total water added was at the rate of 3 millilitres per 20 grams.

That an even distribution may be obtained by stirring small quantities of drugs into minced meat with a little added water is indicated by (a) uniform coloration when, for instance, copper sulphate is employed, and (b) the fact that the behaviour of maggots when tested on different sections of single meat samples was markedly uniform.

It was thought, however, that because of its characteristic unwettability arsenious oxide powder was an exception, and that its toxicity figure, markedly below that of the solution, resulted from its physical properties.

Hatching eggs or larvæ were counted on to the test meat in batches of 25 or 20. The tests were carried out at variable laboratory temperatures of spring, summer and autumn in Sydney and cannot be considered to give more than approximate estimates of the toxicities at, for instance, the temperature of a sheep's body.

TABLE 1.—*Approximate Concentrations (expressed as Parts per Million) in Meat at which the Substances Listed just Prevented the Development of Blowfly Maggots.*

	<i>Luculia cuprina.</i>	<i>Lucilia sericata.</i>	<i>Calliphora stygia.</i>
Arsenious oxide as solution in water..	—	333-400	—
Arsenious oxide as dry powder ..	—	>3600	—
Arsenious oxide as arsenite of soda (80% As_2O_3) dissolved in water ..	166-200	—	—
Arsenious oxide as calcium arsenite dried powder ..	200-225	—	—
Arsenious oxide as calcium arsenite suspension ..	200-225	—	<250
Arsenate of lead ..	—	>1666	—
Paris green ..	330-360	500-600	<360
Sheep dip powder (23% As_2O_3) ..	1000-1250	—	—
Sodium fluoride ..	—	<300	—
Sodium fluosilicate ..	—	166-200	<200
Barium fluosilicate ..	—	166-333	166-333
Nicotine sulphate solution (40% nicotine) ..	200-300	—	—
Derris powder (of 19% ether extract quality) as suspension in water ..	385-500	—	—
Derris powder—water extract (24 hours' extraction) ..	>770	—	—
Mercuric chloride ..	>800	—	—
Boric acid ..	625-800	>1000	>600
Glycerine di-borate ..	2500-3300	—	—
Borax ..	—	>1666	—
Copper sulphate ..	5000-6000	>6000	—
Zinc sulphate } ..	—	>2660	—
Alum ..	—	—	—
Huon Pine oil ..	>5000	<8000	—
Margassa oil ..	6666-10,000	—	4000-8000
Ti-tree oil ..	>50,000	—	40,000-50,000
Tuat oil ..	—	—	>80,000
Cane sugar ..	160,000-200,000	—	—
Carbolic sheep dip (18-20% phenols and cresols) ..	>2000	—	—

Glass cups of about 80-millilitre capacity were used as containers for the meat. They were securely covered with calico to prevent the escape of larvæ or contamination by wild flies, and were kept in the laboratory for 24 hours after the addition of the larvæ. Because of putrefaction the cups were then, after being themselves uncovered, each placed in a calico-covered breeding jar and moved to a shelter outside the laboratory. The jars were of approximately 800-millilitre capacity and about one-quarter filled with moist sand. Maturing larvæ left the meat cups and pupated in the sand. Where no pupation occurred complete development was considered to have been prevented, provided that control lots of meat (with added water only) produced more than 90 per cent. pupation.

Rapidity of Kill.

It was observed that among poisons showing similar toxicity from the point of view of prevention of development, there existed considerable variation in the speed with which larvæ were killed, more particularly by higher concen-

trations. Accordingly an attempt was made to draw some comparisons on the basis of speed of kill. Because of the difficulties of examining and counting very young larvæ in decomposing meat, older maggots were used.

It was found that such maggots transferred from putrefying to fresh meat, poisoned or unpoisoned, showed a marked disinclination to remain on it. A period of starvation before transference was introduced, but was not sufficient alone to keep the maggots on the meat. After being starved for periods of two to twenty-four hours and then transferred to fresh meat all larvæ examined quickly ingested some food and in each batch some would remain on the meat and complete development. Some, however (usually more than 50 per cent.) would crawl out of cups containing unpoisoned meat within an hour after transference.

It was found that when the meat-cups were covered securely with calico, normal development on untreated fresh meat proceeded after a period of restlessness lasting for one or two hours. In speed-of-toxicity tests, the glass cups were kept covered until all deaths had occurred or until it was clear that larvæ would not leave before maturing.

No attempt was made to estimate relative distastefulness among insecticides. A reddening of crops was generally noted soon after transference and particles of Paris green were found by microscopic examination in crops of larvæ killed after three minutes' feeding on Paris green-poisoned meat.

The starvation chambers used were large glass filter-funnels closed to maggots near the outlet by 2-inch discs of brass gauze (48 meshes per inch) set in paraffin. They were covered above by calico through which water was allowed to drip fast enough to keep the inner surfaces of the funnels covered by a water film.

In speed-of-kill tests, concentrations of insecticides in meat were usually approximately five times greater than those which previously were found just sufficient to prevent full larval development.

Starved larvæ in batches of about 50 were placed on test meat and examined at intervals later. Dead larvæ were counted and removed, and exact numbers were arrived at by the count after death or after complete development.

It was found that arsenious oxide in solution or as calcium arsenite at a concentration of 1,000 parts per million killed larvæ of *Lucilia cuprina* more rapidly than did sodium fluosilicate (1,000), copper sulphate (10,000) or boric acid 4,000, 10,000 or even 50,000 parts per million. The results of one experiment in which a number of the most interesting poisons (in blowfly work) were tested simultaneously against the larvæ of *L. cuprina* and *L. sericata* are set out in Table 2. For this experiment the larvæ, when removed from meat to starving chamber, were 23-25 hours old; those of *L. sericata* were noted to be rather considerably larger than those of *L. cuprina*. All were starved for two hours before being transferred to test meat.

TABLE 2.—Mortalities expressed as percentages of blowfly larvae in each batch recorded at the times shown after transference from starving chamber to test meat.

Insecticide.	<i>Lucilia cuprina.</i>		<i>Lucilia sericata.</i>	
	% Mortality.	Time in Hours.	% Mortality.	Time in Hours.
Arsenious oxide (as calcium arsenite)— 500 p.p.m.	98	8	8	8
			12	22
			80	168
1,000 p.p.m.	75	4	31	4
	100	8	55	8
			93	22
2,000 p.p.m.	74	3	25	3
	100	8	96	8
Paris green, 2,000 p.p.m.	85	7	2	7
	100	22	25	22
			66	44
Nicotine (as nicotine sulphate), 1,500 p.p.m.	46	2	0	2
	91	7	63	7
	100	22	90	22
			94	168
Sodium fluosilicate, 1,000 p.p.m.	12	7	3	7
	12	21	3	21
	72	44	43	44
	100	168	100	168
Derris (19% ether extract), 4,000 p.p.m.	33	7	55	7
	75	21	70	21
	100	44	86	44
Boric acid (as glycerine di-borate), 11,000 p.p.m.	3	7	2	7
	100	22	95	22
Continued starvation	2	7	2	7
	30	22	6	22
			50	44

Discussion.

These observations and the results of certain experiments in the field* together with considerations of chemical stability and cost led to the conclusion that among the substances tested for toxicity none was likely to replace the arsenites of calcium and sodium in the preparation of jetting mixtures.

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R. N. McCulloch.

* McCulloch, R. N. : " Jetting for the Reduction of Sheep Blowfly Attack." *Agric. Gazette*, N.S.W., 43 : 565-573, 1932.

TRANSMISSION STUDIES ON THE BANANA BUNCHY-TOP VIRUS.

The banana bunchy top virus has a specific aphid vector, *Pentalonia nigronervosa* Coq., and is destructive only to species of the genus *Musa*. The transmission phenomena of the virus have been examined recently and a summary of results is given in the present paper. Details of the experiments will be published in full at a later date.

Further attempts to transmit the bunchy top disease^(1, 3) by mechanical inoculation have been unsuccessful. Efficient transmission has been obtained with individuals of both the winged and wingless adult forms of the aphid, and with each of the four nymphal stages preceding each of the adult forms. Approximately 46 per cent. of 233 individuals of all stages of the aphid fed as nymphs on recently infected plants have transmitted the disease in subsequent trials.

Adult aphids, fed in the adult stage on infected leaves, have transmitted the virus much less frequently than nymphal forms fed on the same inoculum. Tests of adults and nymphs, individually and in small groups, for relative acquisition of the virus, have yielded differences which are statistically significant.

The virus is not transmitted by infective adults to their viviparous agamic (and only) progeny.

Infection with bunchy top apparently occurs when a minimal dosage of the virus reaches the plant, as increase in number of infective aphids during inoculation affects only frequency of infection and not the severity of symptoms or the minimum incubation period for the disease.

The bunchy top virus may be transmitted by infective aphids in $1\frac{1}{2}$ -2 hours and longer periods of feeding, but not during shorter periods of feeding on susceptible plants. For acquisition of the virus (by nymphs) an unusually long period, of a minimum of 17 hours, is required, and for high frequency of acquisition, a feeding period of 24 hours is advisable.

Temperatures of 10° and 15° C., by retarding the bodily activities of infective aphids and their inclination to feed, reduced the number of successful inoculations obtained under the conditions of the experiments, and may be of some importance in determining the low winter incidence of the disease.

The virus may be retained by infective aphids in daily transfers to fresh plants for periods as long as 13 days after removal from infected plants. During this infective period most, but not all, of the test plants infested contract the disease, indicating that special requirements besides the mere feeding of infective aphids are necessary for transmission of the disease. Nymphal aphids may carry the virus through their moults.

There is a delay or "waiting" period in the development of infective power by *Pentalonia nigronervosa* after feeding on infected plants. The duration of

this period seems to be dependent on the individual, and to vary from a few hours to approximately two days.

The position of inoculation by infective aphids on the leaves of young plants does not greatly influence the rate of infection or the incubation period of the disease.

In infected leaves detached from plants and maintained in a fresh condition, the presence of the virus may be demonstrated after a lapse of at least 12 days.

Although the virus causes systemic infection, it does not pervade every portion of infected plants. Its presence has been demonstrated only in the first-symptom leaf and leaves subsequently developed by infected plants. Within the first-symptom leaf which usually contains relatively few virus "channels", as indicated by the presence of green streaks or vascular bundles showing abnormal phloem structure, the virus is present only in the region of these abnormal areas.⁽²⁾

Ageing of infected plants, if accompanied as usual by pronounced retardation in growth rate, leads to a pronounced fall in availability of the virus. Such plants may be stimulated to more rapid leaf-production by improving their environment, and again rendered highly infectious.

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C. J. P. MAGEE.

⁽¹⁾ Magee, C. J. P. Aust. Coun. Sci. Indus. Res., Bull. 30, 1927.

⁽²⁾ N.S.W. Dept. Agric. Sci., Bull. 67, 1939

⁽³⁾ Wardlaw, C. W. Diseases of the Banana and of the Manila Hemp Plant. MacMillan and Co., London, 1935.

DETERMINATION OF STARCH CONTENT OF SPOTTED GUM TREES.

Recent research work in England on the problem of powder post beetle* control has been concentrated on the food relationships of the larvæ. Work by Campbell,⁽¹⁾ Wilson⁽⁴⁾ and Parkin⁽²⁾ has demonstrated that the food of the *Lyctus* grub consists essentially of starch stored as a plant food reserve in the sapwood of the tree, that a definite relationship exists between the starch content of, and the degree of *Lyctus* attack in the timber, and that starch-free timber is not susceptible to attack.

The *Lyctus* problem is of considerable importance to the timber industry in Queensland. During recent years research has been concentrated on starch studies, especially in relation to spotted gum (*Eucalyptus maculata*), a species which ranks high in both sylvical and commercial importance in this State but which stores large quantities of starch in the sapwood, thus rendering it highly susceptible to *Lyctus* attack.

* *Lyctus brunneus* Steph., Family *Lyctidae*.

The starch grains of *E. maculata* are generally bifacial and round to oval in shape but, due to development as twin or triple grains, some may appear truncated or angled. The largest grains are usually those of independent formation and of oval shape. These may attain the size of about 15μ on the long axis. On such grains the hilum is more or less central and is surrounded by concentric or slightly eccentric striations. Twin and triple grains may or may not be of uniform size. On twin grains the hilum is usually centrally placed on the line of division with confocal parabolic striations. On triple grains the hilum is at the common point with confocal striations.

Method of Testing for Starch.

On the radial face of each sample a clean surface was cut and sprayed by means of a Glaseptic atomiser with an N/20 aqueous solution of iodine made soluble by the addition of potassium iodide. According to the blue colour reaction of the starch present, a visual estimation of the starch content was made by means of a binocular microscope.

Classification of Starch Content.

The preliminary study of starch in spotted gum in Queensland indicated that the estimation of starch content into five grades, 0, 1, 2, 3 and 4, representing intensities of nil, slight, light, moderate and heavy respectively, would suitably meet all requirements for general practical purposes.

Recently, Phillips,⁽³⁾ in England, working on the starch content of English ash sapwood, presented a starch classification of seven grades. This narrower differentiation might prove of some advantage in detailed scientific research on a problem such as seasonal starch variation within a tree, but because the iodine method of estimation is purely visual and therefore liable to personal error it is considered that five grades represent a more adequate working basis easily applicable by both research workers and practical timbermen.

The starch content varies in intensity across the sapwood and is distributed in both the medullary rays and wood parenchyma. A visual estimation of the section as a whole would possibly be accompanied by such an error as would render the results unreliable. However, fairly reliable results have been obtained by adopting five grades and estimating the starch intensity progressively across the section for each one-eighth of an inch of sapwood, and then taking an average for the section. In this way it is possible to obtain figures to 0.1 for comparative purposes.

Example :

	North.	South.	East.	West.
Readings ..	2-3, 3-3	0-1, 4-4, 1-1	1-1, 2-1, 3-4	2-1, 3-3, 2-3
Average ..	2.5	2.8	2.5	2.4

TABLE I.—*The Starch Content at Different Heights and Aspects of the Bole of the Tree.*

Tree No.	Height of Sample.	North.	South.	East.	West.	Average.
	Ft. In.					
7	39 0	4.0	4.0	4.0	4.0	4.0
	23 0	4.0	4.0	4.0	4.0	4.0
	4 6	3.9	4.0	4.0	4.0	3.98
10	32 0	4.0	4.0	4.0	4.0	4.0
	14 0	4.0	3.6	3.7	4.0	3.82
	4 6	4.0	3.7	3.5	4.0	3.80
62	33 0	2.8	3.8	3.0	3.0	3.15
	18 0	3.0	3.5	3.0	3.8	3.32
	4 6	3.5	3.8	2.6	4.0	3.47
70	27 0	2.4	3.0	2.6	4.0	3.00
	15 0	2.3	3.0	3.8	2.7	2.95
	4 6	3.0	3.0	4.0	2.8	3.20
85	28 0	1.7	1.0	2.1	2.7	1.88
	14 0	1.8	2.0	1.8	2.5	2.03
	4 6	2.4	2.8	3.8	2.3	2.83
87	29 0	1.9	2.0	1.8	1.8	1.88
	15 0	1.8	2.0	1.7	1.6	1.78
	4 6	2.5	2.0	2.3	2.3	2.28
99	26 0	2.0	2.2	1.6	2.0	1.95
	17 0	1.7	2.0	2.7	3.0	2.35
	4 6	1.7	2.3	1.5	2.7	2.05
103	24 0	3.8	2.6	2.5	3.0	2.98
	14 0	3.7	2.6	2.9	2.0	2.80
	4 6	2.6	2.7	2.5	2.4	2.55
117	23 0	2.7	1.8	2.7	1.5	2.18
	12 0	2.7	1.6	2.3	2.3	2.23
	4 6	2.5	1.7	2.6	1.7	2.13
Average		2.83	2.77	2.85	2.89	2.84

In the top line, the figures are quoted in pairs; the first of each pair represents the starch grade and the second represents the number of eighths of an inch of sapwood with that grade. By summing the products of the pairs in a section and dividing by the number of eighths of an inch in that section a starch estimation to 0.1 is thus obtained as shown in the second line.

Distribution of Starch Along and Round the Bole of the Tree.

During the course of starch resorption experiments on spotted gum in the Chinchilla district, a number of normally growing trees were felled throughout the year and on these starch intensity determinations were made in the sapwood

at different heights and aspects of the bole from which commercial logs are normally cut. The samples, six inches in length, two inches in width and just exceeding the sapwood in depth, were taken on the north, south, east, and west aspects at breast height, half way along the commercial bole, and at the top of the bole. These were treated with iodine as previously described.

TABLE 2.—*Averages of Starch Content at Different Heights and Aspects of the Bole of the Tree.*

Average Height.	North.	South.	East.	West.	Mean Average.
Ft. In.					
29 0	2.81	2.71	2.70	2.89	2.78
16 0	2.78	2.70	2.88	2.88	2.81
4 6	2.90	2.89	2.98	2.91	2.92
Mean average	2.83	2.77	2.85	2.89	2.84

Although some variations did occur between the several samples from individual trees, the average readings were reasonably uniform and indicated an even distribution of starch through the sapwood with no appreciable variations ascribable to height or aspect.

The practical importance of these points is that samples taken at breast height from normally growing trees should give a fairly accurate idea of the starch content throughout the bole at the time of sampling. In view of the slight variations, it might not be safe to draw conclusions from single samples at breast height but reliability should be possible from two such samples taken on different aspects. By means of an increment borer this can be done without undue injury to the timber or the tree.

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(1) Campbell, W. G. *Biochem. J.*, 23 : 1290, 1929.

(2) Parkin, E. A. *Ann. Appl. Biol.*, 23 : 369, 1936.

(3) Phillips, E. W. J. *Forestry*, 12 : 15, 1938.

(4) Wilson, S. E. *Ann. Appl. Biol.*, 20 : 661, 1933.

The Australian Institute of Agricultural Science

THIRD GENERAL MEETING OF THE INSTITUTE.

Owing to the war, the meeting of the Australian and New Zealand Association for the Advancement of Science has been postponed indefinitely. Thus it is improbable that the Third General Meeting of the Institute, arranged for August 17-18 at Adelaide, will be held at that time. The possibilities are being examined, and an announcement will be made later.

A. J. VASEY,
Hon. General Secretary.

MEETINGS OF COUNCIL.

March Meeting.

Held at the Department of Agriculture, Melbourne, on 20th March, 1940, at 5.10 p.m.
Present: Dr. A. E. V. Richardson (S.A.), Dr. H. C. Forster (W.A.), Mr. H. J. Geddes (T.), Mr. A. B. Hackwell (proxy for Mr. Miller, V.) and the Honorary Secretary, Mr. A. J. Vasey. Apologies were received from Messrs. Miller, Leeper (A.C.T.), Gillespie (N.S.W.), Twentyman and Croll. In the absence of the Victorian delegate, Dr. Richardson was voted to the chair.

It was resolved that the size of the Journal should not be increased pending discussion of this matter at the full Council meeting prior to the next general meeting at Adelaide.

The resolution governing concessions to members of the Institute on active service as recorded in the minutes of the last meeting was agreed to. It was further decided that this concession should date from 1st January, 1940, and that the addresses to which the Journal and Institute correspondence might be sent should be decided by the members concerned.

The Hon. Secretary reported that the *per capita* rebates to Branches, approved at the last meeting, had been paid.

The suggestion of the Victorian Branch that the time was ripe for the publication of a further list of members of the Institute was discussed. It was felt that further details should be included and an effort should be made to approach the standard of the List of Agricultural Research Workers of the British Empire.

April Meeting.

Held at the School of Agriculture, Melbourne University, on 22nd April, 1940, at 7.45 p.m. *Present:* The President, Prof. R. D. Watt (in chair), Dr. A. E. V. Richardson (S.A.), Dr. H. C. Forster (W.A.), Mr. J. L. Gillespie (N.S.W.), Mr. G. W. Leeper (A.C.T.), Mr. W. B. Miller (V.), Mr. P. S. Lang (Q.), Mr. H. J. Geddes (T.), the Honorary Treasurer, Mr. R. L. Twentyman, and the Honorary Secretary, Mr. A. J. Vasey. An apology was received from the Assistant Honorary Secretary, Mr. R. D. Croll.

Support was obtained for the proposal to publish a further list of members of the Institute, and it was decided that this should be done in the December, 1940, issue of the Journal. The exact form which this list should take and the details to be included therein were to be listed for discussion at the next general meeting.

The following were admitted to corporate membership: J. L. Williams (S.A.), R. W. Spicer (Vic.), F. L. Milthorpe (N.S.W.), E. P. Baker (N.S.W.), C. E. Ahrens (N.S.W.).

Correspondence included a letter from the Honorary Secretary of the N.S.W. Branch under date 28/3/40, forwarding Dr. R. J. Noble's resignation from the Central Quarantine Committee, also a newspaper cutting from *The Sydney Morning Herald* of that day dealing with Dr. Noble's appointment as Under Secretary of the Department of Agriculture. He advised that Dr. Noble had been compelled to resign from the Quarantine Committee owing to the pressure of official duties in his new position. The Council decided that Dr. Noble's resignation should be accepted with regret, and also that the congratulations of the Council on his appointment to such an important position should be conveyed to him. It further decided that Dr. H. J. Hynes should be invited to accept appointment to the Central Committee on Plant Quarantine in place of Dr. Noble.

The financial statement showed a balance at bank on April 22nd, 1940, of £201 5s. 2d.

After discussion regarding the next general meeting of the Institute (see notice above), the Hon. Secretary was directed to draw the attention of Branches to Article 40 governing this matter, and to circulate a list of members eligible for election.

The Honorary Treasurer moved and Dr. Forster (W.A.) seconded a motion that Messrs. Cleveland, Son and Hislop, of 20 Queen Street, Melbourne, be appointed auditors of the Institute accounts for 1939, and that the books be delivered to them for examination as soon as possible.

MEETINGS OF BRANCHES.

Canberra Branch.

A general meeting on 7th February, 1940, was addressed by Mr. J. C. Stephen, Production Officer of the Commonwealth Bureau of Census and Statistics. His subject was "Statistics of Primary Production—Collection, Tabulation, and Presentation". He pointed out that data were collected by the six States and the Commonwealth. Much of the actual gathering of statistics on primary production was done by local police officers, who interviewed producers in their respective districts. This information was tabulated by State statisticians, and figures from all the States were collated by the Commonwealth, which periodically forwarded data to the International Institute of Agriculture at Rome, and to the decennial world census. Data were collected from about 250,000 farms. The speaker outlined methods of checking the accuracy of statistical data, and reviewed present trends and possible future requirements.

The fifth annual general meeting and dinner were held on March 5th, 1940. Dr. L. B. Bull, Mr. D. A. Gill, Dr. J. H. Riches and Mr. A. J. Vasey were present as guests. The following were elected as Branch officers for 1940: President, Dr. J. R. A. McMillan; Hon. Secretary-Treasurer, Mr. A. V. Hill; Delegate, Dr. B. T. Dickson; Sub-Editor of Journal, Dr. W. V. Ludbrook; Members of Committee, Dr. J. G. Davies, Messrs. R. M. Moore and F. N. Ratcliffe; Auditors, Messrs. E. Mackinnon and S. Gray. The membership of the Branch is now 31.

Dr. L. B. Bull, Chief of the Division of Animal Health and Nutrition, C.S.I.R., opened a discussion on pasture management with respect to the requirements of animals. He contended that pasture should be managed to suit the varying requirements of the animals being grazed, rather than subjected to a fixed routine convenient to the farmer. Pasture of high protein content is essential for milk and wool production, but less important for fattening. It should be the farmer's aim to provide a pasture for a definite purpose rather than to think of it in terms of feed for any stock which he happens to have or can obtain. Excess pasture should be conserved as silage rather than as hay, since more of the valuable protein content is retained in silage. The rapid growth and high water content of improved pasture often causes scouring of grazing animals, and consequent waste of nutriment. Supplementary dry roughage is desirable to counteract this. Dr. Bull did not consider that excess protein in pastures was conducive to stock diseases; it was objectionable

mainly from the economic viewpoint. A higher protein content in Australian pastures is more important than increased mineral content, especially for sheep. Several members and visitors contributed to the lengthy discussion that followed.

Dr. E. T. Edwards, of the Biological Branch, N.S.W. Department of Agriculture, addressed a general meeting on April 22nd, 1940. He spoke on aspects of research in plant science overseas, with particular reference to institutions visited during his recent tenure of a Commonwealth Fund fellowship. Dr. Edwards said that portions of the south of the United States were experiencing considerable difficulty and economic distress in connection with the change from one crop to mixed farming, necessitated by the over-production of cotton and by soil erosion. "Hybrid corn" was referred to as the most outstanding recent development in American agriculture, and the organisation for producing and distributing hybrid seed was described. Stress was laid on the results achieved by co-operative effort in this and other projects, e.g. studies on the effect of varying placement of fertilisers. It appeared that in general, the concentration of fertilisers in a band slightly below and to one side of the seed gave better results than other methods of application. A number of Kodachrome colour films were screened, and formed a valuable adjunct to the address. Dr. Edwards stated that these were being found very useful for scientific records, e.g. of pathological specimens, microscopic preparations, etc.

New South Wales Branch.

An extraordinary general meeting was held at Science House on March 18th, to discuss business arising from communications of the Management Committee with the N.S.W. Public Service Board. The letter from this Committee, indicating a desire to set forth to the Board its views on the organisation of agricultural research and extension, and the encouraging reply from the Board, were read. After full discussion, a committee of five members was elected to develop and express the views of the Branch.

At the April meeting, held on 12th of the month at Science House, the report prepared by this committee and sent to the Public Service Board—together with the reply, expressing appreciation of the suggestions made—was read.

The main items of business were the presentation and discussion of the reports of the sub-committees that had been set up to investigate foreign plant quarantine, and the N.S.W. agricultural potentialities survey. Branch approval was given for the committee of the last named project to approach banks and the Government to acquire funds to successfully carry out its survey. Dr. R. J. Noble's resignation from the plant quarantine committee was accepted and Dr. H. J. Hynes' appointment in his place was endorsed. The meeting extended its hearty congratulations to Dr. R. J. Noble on his appointment to the position of Under Secretary. A complimentary dinner was tendered to Dr. Noble at "Vere Mathews" on 31st May, at which a large number of Institute members were present.

At the May meeting, the main business was an address by Dr. E. T. Edwards on "The American Hybrid Maize Programme and its Possibilities in Australia", which will appear as an article in a subsequent issue of this Journal.

Victorian Branch.

A general meeting was held on February 28th, when an address entitled "British Agriculture Revisited" was given by Professor S. M. Wadham. (Attendance, 72.) The address is reported elsewhere in this issue.

The fifth annual meeting was held on May 3rd, being a business meeting for members only (attendance 30). The annual report showed that there had been steady progress in the affairs of the Branch, the membership being 113 (110 corporate, 3 student), a net increase of 11 members. Of these, 108 were financial for 1939. Branch income and expenditure were approximately £33 10s. and £30 respectively. These sums do not include

the special grant of £11 16s. made by the Federal Council for the purchase of maps for the agricultural potentialities survey and of which £4 7s. was expended in 1939.

Four meetings of the Branch were held during the year, and in addition eight meetings by the allied body, the Melbourne University Agricultural Society (average attendance 51).

Progress reports were presented on the agricultural potentialities survey, salary and status survey and the plant quarantine projects, and respective sub-committees re-appointed. On the soil erosion project, the meeting approved of the draft memorandum prepared conjointly by sub-committees of the Institutes of Surveyors, Engineers, Foresters and Agricultural Science for presentation to the Victorian Government. The memo. emphasised the national importance of the problem and recommended the formation of a soil erosion board to institute organised control.

The Branch agreed to cooperate in a war-time research project being undertaken by the Australian Institute of International Affairs.

In regard to general Institute finance, the meeting supported the policy of assisting branch activities by increasing *per capita* rebates in preference to the allocation of special grants for specific projects; further it recommended that net expenditure on the Journal this year should not exceed that of 1939, and if it were necessary to reduce the size of the publication, the reduction should apply to articles and reports of addresses, in preference to reports of Council and Branch activities, technical notes and reviews.

Mr. F. M. Read was elected President and Branch Delegate for the ensuing year, Mr. C. E. Cole Hon. Treasurer, and Mr. A. B. Hackwell Hon. Secretary.

Members attended the 18th annual meeting of the M.U.Ag.S. held on April 12th (attendance 50). The presidential address was given by the retiring president, Mr. L. C. Bartels. Under the title "We Know Better Now", Mr. Bartels traversed the progress made in irrigated farming practices in Victoria during the last 30 years. It was impressed upon settlers very early in the history of the State that irrigation must necessarily accompany the full and profitable occupation of the drier parts of Victoria. In 1910 there was a paucity of information for the guidance of farmers, but since that time there had been an evolution in regard to irrigated agriculture. It was pointed out that the first graduate in agricultural science in Victoria was admitted to the degree in 1911, the State Research Farm was established at Werribee in 1912, and the developments in irrigated agriculture were at least contemporaneous with the growth of the School of Agriculture. Lucerne was the basic crop in the development of the irrigated areas, but the cultivation of mixed pastures must be regarded as the most noteworthy development of irrigated agriculture of recent years. Mr. Bartels, with the aid of a film strip, then went on to discuss the various problems associated with the reclamation of salted lands, the maintenance of soil fertility, the time and rate of application of water, manurial treatments and the proper layout and grading of land to permit the optimum distribution of water. In discussing the permanence of irrigated agriculture, Mr. Bartels stated that it was too much to hope that the difficulties attendant on irrigation farming would be removed, but when industry, common sense and conscience prevailed, stability and permanence would be established. Many of the mistakes of the past would not be repeated because we know better now.

The membership of the M.U.Ag.S. for 1939 was 145, including 17 life members. Mr. O. H. Gepp was elected president for 1940.

Queensland Branch.

The fifth annual meeting was held on March 1st. The election of office-bearers resulted as follows: President, Mr. C. S. Christian; Vice-Presidents, Messrs. A. F. Bell and J. H. Smith; Hon. Secretary-Treasurer, Mr. C. W. Winders; Hon. Sub-Editor, Mr. J. A. Weddell; Members of Branch Committee, Messrs. N. E. H. Caldwell, C. J. McKeon and P. J. Skerman; Hon. Auditor, Mr. E. W. Bick. The presidential address, delivered by the retiring President, Mr. A. F. Bell, dealt with "Government Participation in Agriculture".

The 28th ordinary meeting of the Branch, held on April 19th, took the form of a Notes and Exhibits night. Mr. C. R. von Stieglitz exhibited a field testing kit for the determination of soil lime requirements on the spot. This kit was made locally, similar sets having been supplied to the several field officers of the Bureau of Sugar Experiment Stations. Essentially, it is a compact and simple soil pH kit complete with test tubes, reagents, indicators and a limited range of comparator tubes. Mr. E. R. Behne, in a short address, surveyed power alcohol production in Queensland. Mr. S. T. Blake showed (a) a photo of a somewhat spectacular example of soil erosion, and (b) a grass specimen, *Brachyachne convergens*, that had been involved under particular circumstances in serious stock losses in the St. George district, due to HCN content. Mr. A. R. Brimblecombe gave an account of starch determination and starch resorption experiments in timber. Sapwood of high starch content is susceptible to *Lyctus* borer attack. Hence, the work mentioned is part of a major project aiming at increasing the value and durability of the sapwood of particular timber species.

South Australian Branch.

The annual general meeting was held on March 28th. The following office-bearers were elected: President, Dr. A. R. Callaghan; Vice-President, Mr. D. B. Adam; Hon. Sub-Editor, Mr. J. K. Taylor; Hon. Secretary, Mr. T. T. Colquhoun; Hon. Treasurer, Mr. C. S. Piper; Committee, Dr. I. F. Phipps, Mr. A. G. Strickland and Dr. A. Walkley.

The reports of the Treasurer and the Secretary were read and adopted. The sub-committee for plant quarantine tabled a report which it was decided to forward to the central committee for consideration.

Two addresses were given by members recently returned from abroad. Mr. A. G. Strickland, who represented the Commonwealth at the International Congress on Agriculture at Dresden in 1939, which was attended by delegates from 54 countries, spoke on the organisation, conduct and business of the meeting. He touched briefly on the subject matter discussed in the nine sections into which the congress was divided.

Professor J. Davidson spoke on "The Significance of Grass-legume Association in Northern European Countries". During his trip abroad, Professor Davidson visited Denmark, Sweden and Finland and saw the results of investigations bearing on this subject. It was intimately bound up with the health of the people, who depend largely on a diet of cereals, milk, milk products and potatoes. One of the major difficulties was the maintenance of supplies of vitamin A during the long winter months, and he described research work in Finland designed to rectify this trouble.

Western Australian Branch.

The annual general meeting was held on April 26th, when the following office-bearers were elected for the ensuing year: President, Mr. A. M. Stewart; Vice-President, Mr. F. L. Shier; Hon. Secretary, Mr. R. P. Roberts; Hon. Treasurer, Mr. A. B. Cashmore; Committee, Mr. W. P. Cass Smith, Professor G. A. Currie, Dr. T. C. Dunne, and Dr. E. J. Underwood; Sub-Editor of the Journal, Mr. G. H. Burvill.

The retiring President, Dr. G. L. Sutton, delivered his presidential address, entitled "Some Factors which have Contributed to the Progress of Agriculture in Western Australia during the past Three Decades". Dr. Sutton traced the enormous expansion in agriculture during this period, and related it to the various major economic, political and scientific influences of the same period. The dwindling gold yield after 1905, liberal land laws and monetary advances under the Agricultural Bank Act all promoted agricultural progress, especially wheat farming. Later, post-war immigration brought about the expansion of dairying in the south-west of the State. Agricultural science had played a large part in solving some of the unique problems associated with agricultural expansion. Dr. Sutton drew attention to human factors throughout the talk, especially to illustrate the difficulties encountered by settlers and their wives.

Current Notes and News

New Under Secretary for N.S.W. Department of Agriculture.

On March 27th, Dr. R. J. Noble, Ph.D., M.Sc., B.Sc.Agr., was appointed Under Secretary of the N.S.W. Department of Agriculture, in succession to Mr. G. D. Ross, who retired because of ill-health. For a period of thirteen years previous to this appointment, Dr. Noble was Chief Biologist.

This appointment marks the latest achievement of a brilliant career. Dr. Noble, who was born at Five Dock, N.S.W., on May 17th, 1894, was one of the first group of scientific cadets appointed to the N.S.W. Department when the system was introduced in 1913. In 1915 he graduated B.Sc.Agr., with first-class honours and the University Medal. In his course work he had won the Belmore Scholarship for chemistry and geology and the J. H. Maiden prizes for agricultural botany and forestry. Immediately after graduation he enlisted and served for four years with the A.I.F. in Egypt and France, and was A.V.C. sergeant in the 5th Machine Gun Battalion. After the Armistice, he was appointed agricultural instructor at the A.I.F. Training Dépôt Sutton Veny, and subsequently worked with Beaver, the barley breeder, at Warminster.

He returned to Australia, and in the following year, 1920, was awarded the Ben. Fuller Post-graduate Scholarship and proceeded to the University of Minnesota, where he gained the M.Sc. in 1922 and the Ph.D. in 1923, the theses dealing with several phases of flag smut in wheat. While at Minnesota, he represented the Australian Commonwealth at the International Conference of Cereal Pathologists, in June, 1921.

On returning to the N.S.W. Department, Dr. Noble was appointed Principal Assistant Biologist and later, in 1927, Biologist. From that time he extended considerably the biological work of the Department, and his advice and influence have left their mark on many departmental activities. In his new position, he is particularly well qualified and experienced to administer the Department. He has contributed numerous scientific papers to the Royal Society, to this and other scientific agricultural journals, as well as many departmental publications.

Of his many other activities and affiliations, the following may be mentioned: Royal Society, President 1934, Hon. Secretary 1929-34; Fellow, A.N.Z.A.A.S.; Aust. Inst. Agr. Sc., N.S.W. Branch, President 1936; Member National Research Council and the State Committee of the C.S.I.R. 1933; President, Syd. Univ. Agr. Grad. Assn. 1924; Chairman, Committee of the Standards Association 1936; Delivered lectures in advanced Mycology in Faculty of Science, Sydney University 1930; Correspondent in Plant Pathology for International Inst. Agric. Rome 1927; Member Sigma XI and other American fraternities.

Corrigendum.

On p. 6 of Vol. 6, No. 1, of this Journal, the fourth and fifth sentences in paragraph 3 should read as follows:

The amount spent in extension work in the United States in 1936 was 30½ million dollars, or approximately £6 million; that is, about £46,000 per million of population (see *Meeting the Challenge in Agriculture*, U.S. Dept. of Agr. Extension Service). In proportion, our State should spend £125,000, whereas last year £143,000 was spent on educational, scientific and field work.

Book Review

HANDBOOK OF PHYTOPATHOGENIC VIRUSES, by FRANCIS O. HOLMES.
(221 pp., Burgess Publishing Company, Minneapolis, Minnesota, U.S.A., 1939. Price, 2 dollars.)

This book supplies the need for a concise arrangement of data concerning most of the plant viruses and bacteriophages that have received study. It is thus a very useful handbook, although Dr. Holmes had in mind a more important function when he compiled it. He desired to amplify a plan he conceived for naming and classifying viruses outlined by him in *Phytopathology* 29, pp. 431-436, 1939.

In an endeavour to improve on the present unsatisfactory numerical system of virus nomenclature, the author has devised a latinised binomial system embodying for the plant viruses the genera *Chlorogenus* (Yellows viruses), *Marmor* (Mosaic viruses), *Annulus* (Ringspot viruses), *Galla* (gall and vascular proliferating viruses), *Acrogenus* (Spindle-tuber type viruses), *Ruga* (Leaf-curl viruses), *Corium* (Potato leaf-roll type viruses), *Nanus* (Dwarfing viruses), *Savoia* (Savoy disease group) and *Lethum* (Spotted wilt type). For the bacteriophages, the genus *Phagus* is provided.

This nomenclature is ingenious but unnatural. The viruses are grouped according to the class of symptoms they cause rather than on inherent characters of the pathogens, about which, of course, little is known. To the writer, Dr. Holmes' system has more disadvantages than the present numerical codification. An animate nature for viruses is implicit in the erection of genera and species, and for a group of pathogens producing symptoms which vary widely with the host and the environment, naming on the basis of symptoms must cause confusion, or be very arbitrary. Thus there does not appear to be justification for separating widely the genus *Lethum* from *Marmor* when some of the viruses included in the latter group have a necrotic phase, and the secondary phase of the disease caused by *Lethum australiense*, the type species, appears as one of the best defined mosaics.

Much care has been taken in the collection of data relevant to each virus but certain errors usual to compilations occur. In particular, the *Musa* viruses are badly treated. Dr. Holmes is to receive congratulation on having produced a useful handbook, but it is a pity that a more provisional system of arrangement for these little known pathogens was not adopted.

C. J. P. MAGEE.

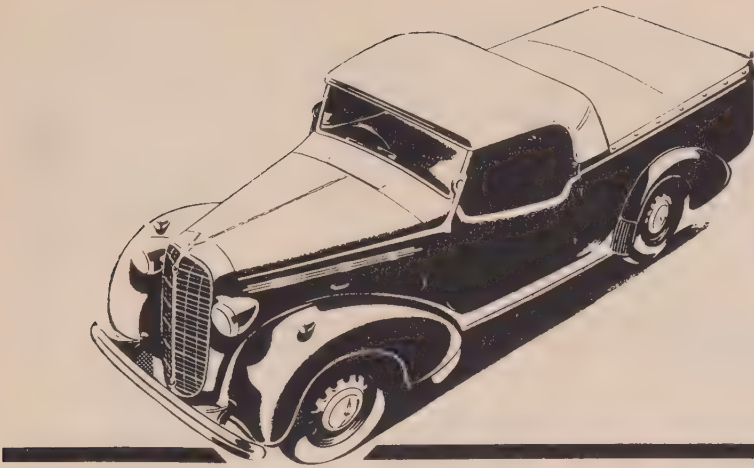
Personal Notes

Dr. L. J. H. Teakle, of the Department of Agriculture, Perth, has recently been elected as a Fellow of the Australian and New Zealand Association for the Advancement of Science and a member of the National Research Council.

Mr. R. W. Spicer has been appointed an agricultural research officer for the Shell Co. of Australia Ltd.

Flight-Lieut. J. P. Ryland, of Victoria, is now a member of the R.A.A.F., and is stationed at Laverton.

Mr. E. A. Southey is now, as Principal of Hawkesbury Agricultural College, in his twentieth year of office, thereby eclipsing the late Principal Potts' previous record of 18½ years. Incidentally Mr. Southey's tenure at Hawkesbury has been longer than that of any other principal of an agricultural college in the Commonwealth.



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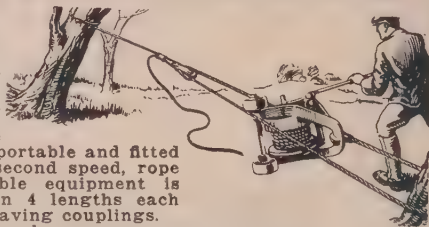
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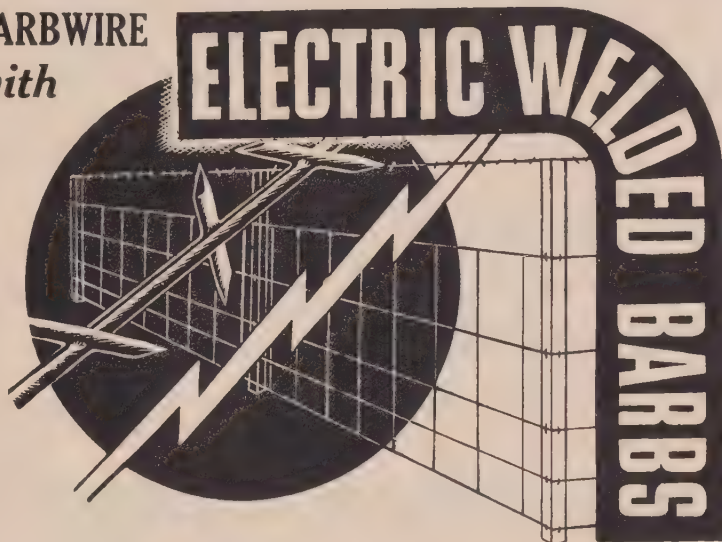
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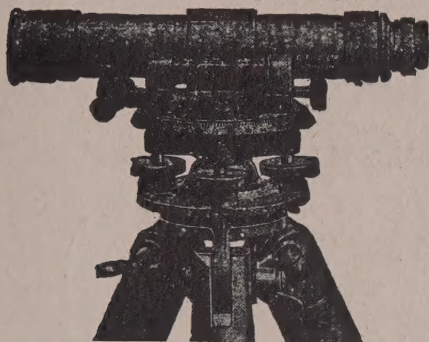
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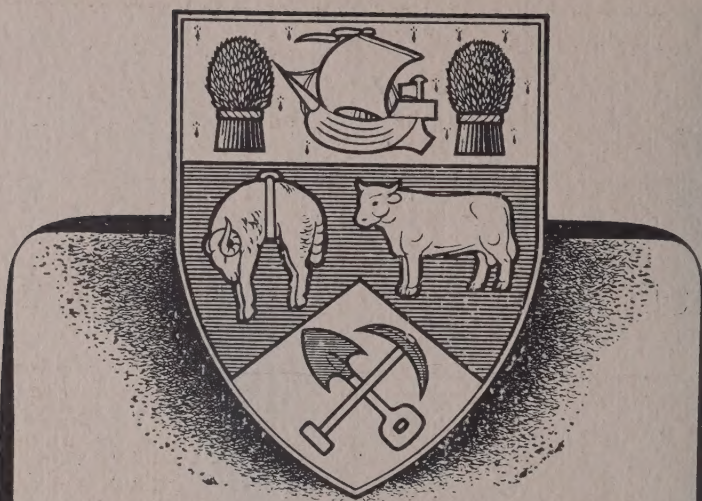
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